TcpStereo

Version 2.0

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REFERENCE MANUAL

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1. INSTALLATION

1.1. REQUIREMENTS

In order to ensure that the application functions correctly, the user should have system hardware which is suitable for viewing stereo images, such as application support software (operating system and drivers).

Hardware requirements

- Dual Core 2 GHz processor or better.
- 2 Gigabytes RAM memory or more.
- DVD reader.
- Normal graphics card, with 256 MB and support for OpenGL 1.0 or NVidia Quadro FX 256 MB graphics card or better, in order to see models on other supported stereo systems.
- Stereo vision system compatible with the graphics card:
  - Active stereo through *NVidia 3D Vision* type LC shutter glasses and monitor.
  - Active stereo through *NuVision* type CRT shutter glasses and monitor.
  - Passive stereo through *Zalman Trimon* type horizontal polarization monitor.
  - Passive stereo through LCD monitors and *Planar* type polarizing mirror.
  - Passive stereo through anaglyph glasses (color filters).

Software requirements

- Microsoft Windows 32-bit XP or Vista operating system with all the latest updates.
- Microsoft VC++ 2008 and 2010 Runtime and Microsoft .NET framework v4.0
- CAD design software:
  AutoCAD 2004 to 2007.
  AutoCAD 2008 to 2015 (32 or 64 bits).
  Bricscad v9 to v15.
- Updated drivers for the graphics card used.

Note: *You may obtain further information on the different stereo vision systems by visiting the websites of the respective manufacturers.*

1.2. INSTALLATION PROCESS

Insert the installation DVD into the corresponding drive - the installation program will start up automatically. If it does not start, run file X:\setup.exe, where X = DVD drive.

The conventional installation process for the various Windows platform programs will be executed immediately. You will need to have ***administrator privileges*** in order to install the programme. You will initially need to have the application's pre-requisite software installed:

1. Microsoft .NET Framework 4.0.
2. Microsoft Visual C++ Runtime 2008 and 2010.

Read the license carefully. In the event that you do not accept the term contained therein, cancel the process and return the program to the distributor.

Figure 1 – Installation: License of use.

Insert your name and company, select the folder in which you wish to install the program and set the users shall use the application. It is recommended that you have a hard disc with space enough (gigabytes) if you want to install examples and create new projects.

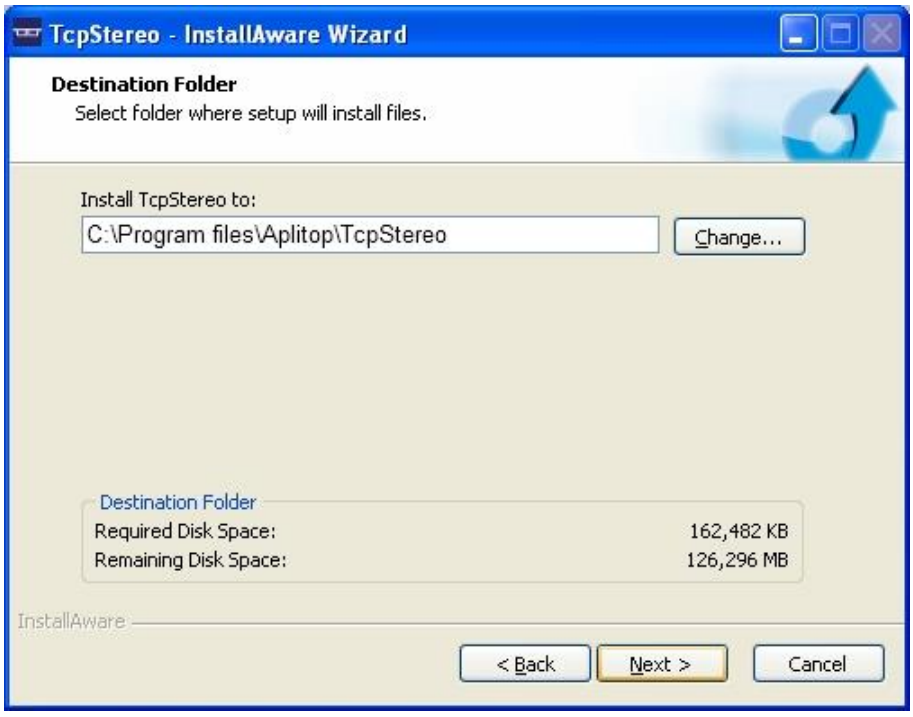


Figure 2 – Installation: application folder selection.

Once the process has finished, the installer will copy the necessary files and create the elements required for your system.

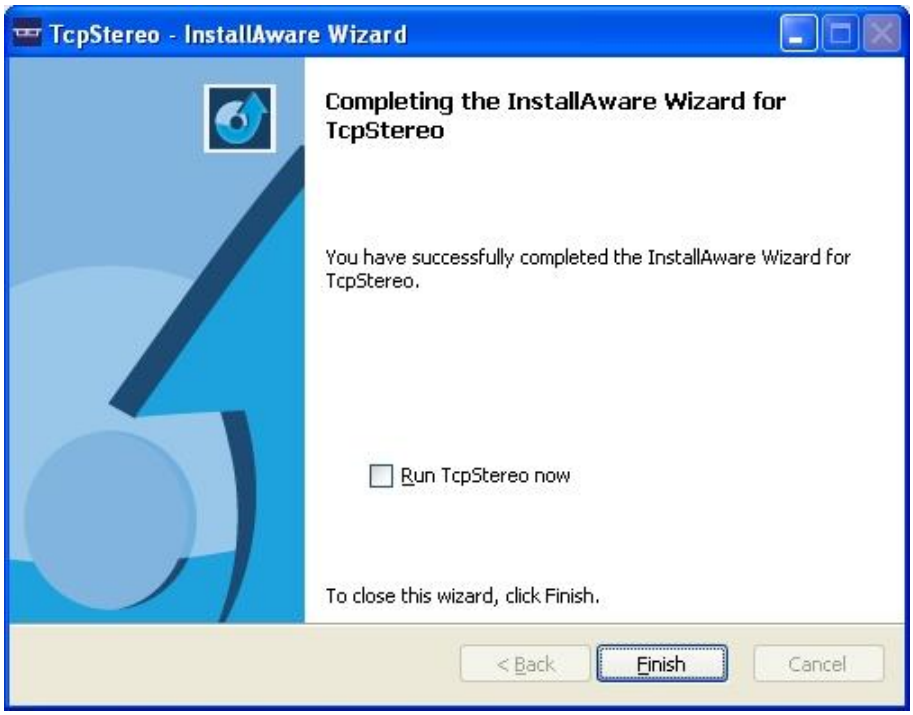


Figure 3 – Installation: finishing the process.

Once the program has been installed, it is advisable to reboot the computer in order to ensure that the changes you have made come into effect.

1.3. POST-INSTALLATION

Installing the Protection Key

Inserting the Protection Key (USB)
Once the application has been installed, connect the USB key to any free USB port on your PC. The system will recognize the key automatically. If it does not, consult the support document.

Tutorial

Make use of the examples included on the installation DVD - practice with them, learn how TcpStereo works in order to get maximum benefit from its functions. These examples may also be downloaded from our website (www.aplitop.com); they are, however, lower resolution images to reduce download size.

In the ***Users Manual*** there is a quick guide that shows how to open and import projects, based on these examples, which can be used as a tutorial.

Customization

In Section 4 of this manual you will find all the information you need in order to customize various aspects of the application, allowing you to adapt it better to your personal preferences and way of working.

1.4. TROUBLESHOOTING

The installation program automatically installs the drivers needed for the proper running of the program's protection. Only if a network license is acquired is necessary to carry out some further operations after the program has been installed.

If, on starting up the program, you see the message **"ERROR: Hardlock not found"** or similar, it may be the case that the protection drivers have not been installed properly. To ensure correct installation, run the **setup.exe** file in the **drivers\sentinel** folder of the program DVD. Once the installation has been completed, reboot the computer.

In order to solve other problems that might arise during the installation or use of the software, there is product support information on our website.

2. CONCEPTS AND DEFINITIONS

In order to understand how the program works, we should explain certain concepts relating to aerial photogrammetry, given that the application is based on these concepts.

2.1. IMAGE

The images are the aerial photographs taken during photogrammetric flights. Each image is contained on an image file in a specific format. The image file format used by the program is TIFF (Tagged Image File Format), usually used for digital photographs and scanned analogue photos.

If the image format is other than TIFF, you may convert them to this format using an image editing program.

2.2. INTERNAL AND EXTERNAL ORIENTATION

In order to be able to use an image, its internal and external orientations need to be known.

The internal orientation consists of a set of parameters that allow us to transform image file pixels to the real physical dimensions (in millimeters) of the photograph and vice-versa. These parameters are principally deduced from the camera characteristics, such as the focal distance, the principal point, the physical dimensions of the photograph, and certain lens distortion values. Additionally other flight characteristics are used, such as flight height and terrain.

The internal orientation of digital images is obtained through metadata contained in the corresponding image files.

The external orientation determines the exact position and orientation of the camera at the precise moment that the photograph was taken. It consists of three-dimensional coordinates X, Y and Z, referred to as the photo-center, and three rotations Ω, Φ and K (with respect to XYZ axes), with Ω and Φ values usually close to zero.

External orientation tends to come in a flat text file (ASCII) where for each photograph there is a line of form:

Nº Photograph X Y Z Ω Φ K

The order of the fields might vary, or the field separator may not be the tabulator. More fields may also appear in these lines with additional information. In any event, the photograph number must always be present, as must the photo-center coordinates and the three angles of rotation.

2.3. MODEL

A model or stereoscopic pair is simply a pair of consecutive and oriented images which share a common area known as the overlap. This overlap is what allows the image to be seen in stereo, as it shows the same area seen from two distinct points. External orientations determine the way in which these images align at each point of the overlap.

2.4. STRIP

A strip can be defined as a set of consecutive photographs. We can also see a set of consecutive models where an image is a part of two consecutive models. The external orientations of the images determine the direction of the strip.

2.5. PHOTOGRAMMETRIC BLOCK

It should be remembered that in order to cover a section of terrain, a number of strips may be required to ensure that the set of images completely covers the area of interest. A block is the strip or group of strips that cover the area of interest in question. For small projects the block may consist of only one or two strips, with just a few images per strip, whilst large projects may require a number of strips with each consisting of considerably more images. Generally, photogrammetric blocks are shown in rectangular form, with the strips arranged in lines.

The strips in a photogrammetric block tend to have overlaps, meaning that a strip image also has a certain overlap with images from earlier and later strips.

2.6. PHOTOGRAMMETRIC FLIGHT AND CAMERA REPORT

When a photogrammetric flight is made, a report is created which reflects the flight characteristics (type, area, measures employed, flight data, images etc.) which accompanies the camera calibration report. In both reports there are a large amount of the parameters required for image orientation.

2.7. PHOTOGRAMMETRIC PROJECT

The photogrammetric project now needs to be defined, as a set made up of the concepts shown earlier, in other words:

- A set of oriented images.
- The models and strips that make up the images.
- Camera and flight parameters.

3. USER INTERFACES

Here we shall explain the operation of the program based on the user interface. This will allow us to show what can be done and how to do it at the same time.

In order to access the application's main functions and characteristics, we will be using the menu bar or the main toolbar which can be seen at the top of the program's main screen.

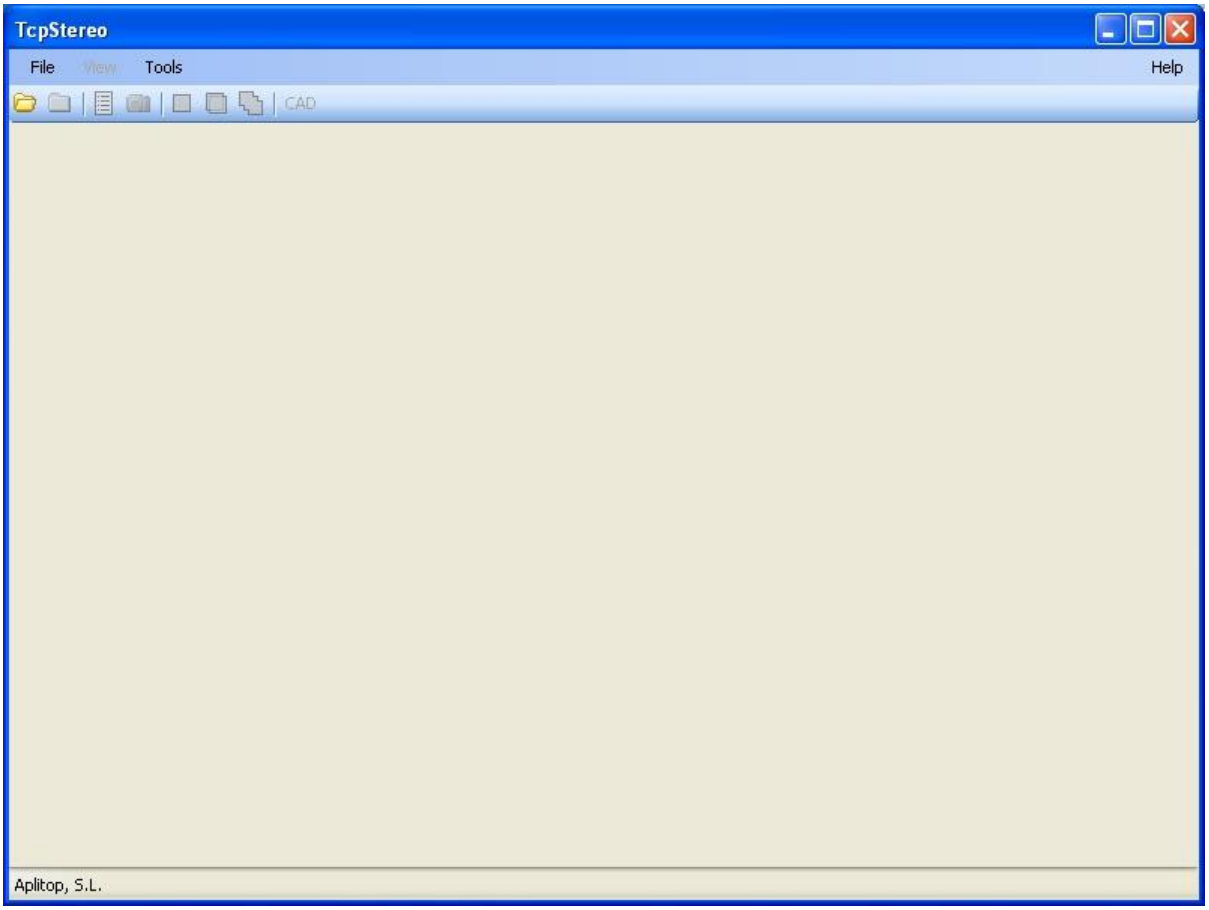


Figure 4 – Main TcpStereo interface

The status bar at the bottom of the screen will show various messages in order to reflect the current state of the program and the action being taken at any moment.

You may close the application by closing this window, or through the menu bar via ***File > Exit***.

Main toolbar 

The functions will be outlined in greater detail in the different parts of this section. To give you an idea, we will outline the buttons from left to right, making it easy to understand what function each is responsible for.

- Open project → Shows the selection dialogue of the project in order to open it.
- Close project → Closes the project that you have open.
- Project properties → Shows the properties of the current project.
- Camera properties → Shows the properties of the project camera.
- Show image → Shows the current image.
- Show stereo → Shows the current model.
- Show block → Shows the project block.
- CAD → Connects to the CAD you have set up (see ***Customization***).

3.1. PROJECT

A TcpStereo project is really a structured set of data and image files, allowing the user to view images, models and the block from a photogrammetric flight, as well as the parameters used to show these elements. The hierarchical structure of folders and files used by a project is as follows:

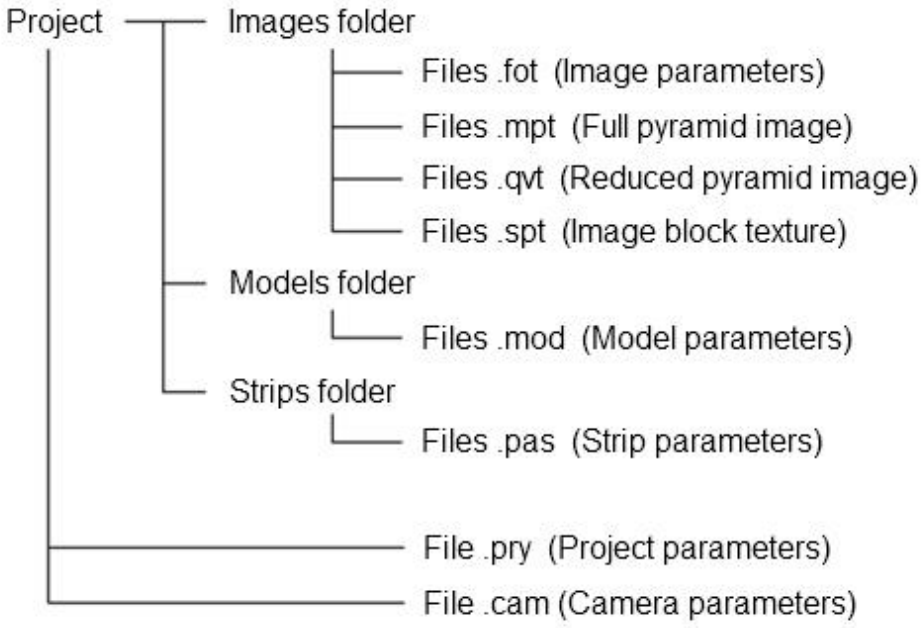


Figure 5 – Project file structure.

The project can be seen as a single document, which can be created and consulted through the TcpStereo program. TcpStereo does not eliminate or alter any files from the project folders, as this might produce errors and even make it impossible to open the project.

3.1.1. OPENING AND CLOSING

In order to open a project, use the menu bar via the following sequence ***Archive > Open project…*** or via ***Open project*** from the main tool bar.

A dialog box “Select Project File” will open, inviting you to open the project folder and select the project file (.pry) you wish to open.

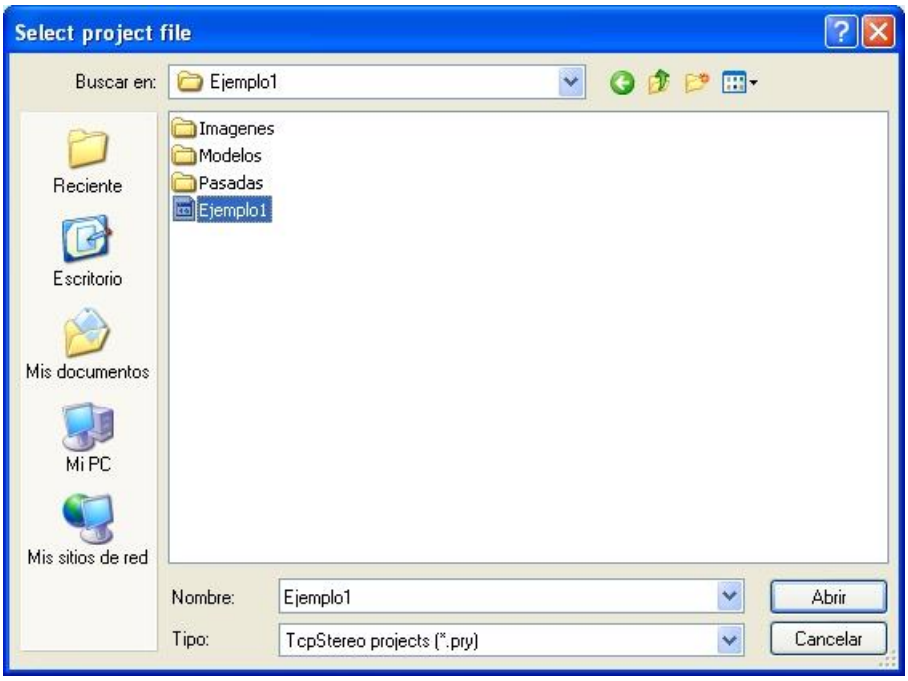


Figure 6 – Project selection dialog.

Once the project file has been selected, TcpStereo will load the project and show a view of the block.

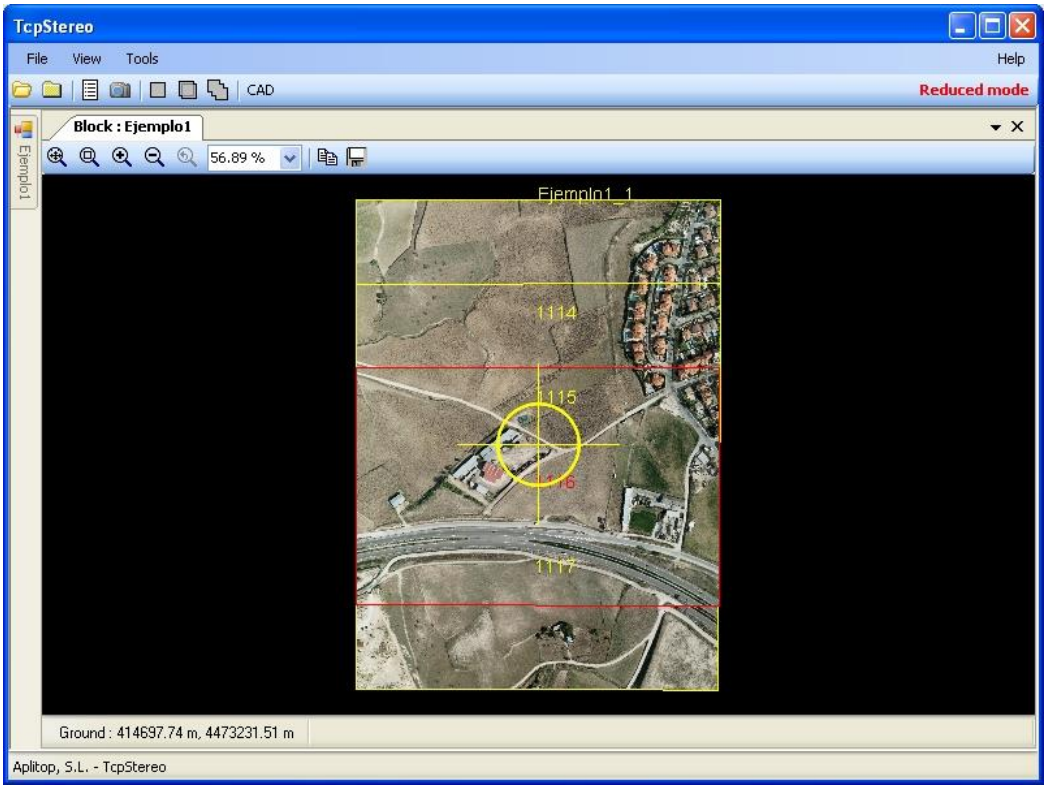


Figure 7 – Loaded project.

The project can be closed using the menu bar via the sequence: ***File > Close*** or via ***Close project*** from the main tool bar.

3.1.2. IMPORT

TcpStereo can import projects from a number of other sources:

- From the data from digital photogrammetric flights with inertial sensors.
- From a subset of project files oriented in Digi3D.

In both cases the essential information is the same.

- Photograph image files.
- Flight parameters.
- Camera parameters.
- Internal and external orientation parameters.

Import project from a digital photogrammetric flight

Use the import option when you have digital images created by a digital photogrammetric camera and an external orientation file generated by the inertial sensors in the plane.

In order to import this kind of project, use the bar, entering ***File > Import project > From flight data…*** An "Import digital flight project" dialog box will appear, as can be seen in Figure 8.

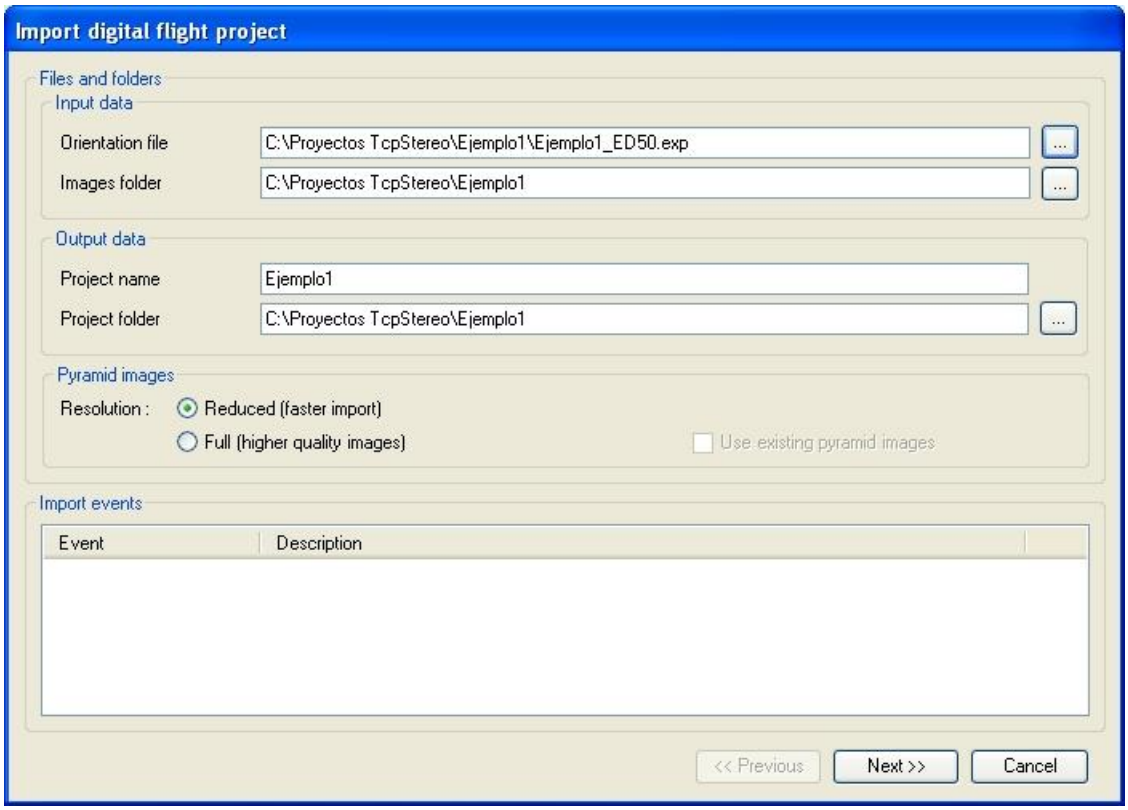


Figure 8 – Project selection dialog.

You will firstly need to indicate the location of the entry data, that is to say, the file that contains external orientations, and in what folder the image file can be found. All the images must be in the same folder.

You should also decide what name to give the project and in which folder the information obtained will be saved (ensuring that it has sufficient space).

Finally, you have the option to carry out the import in two different ways:

- Creating reduced pyramid images:
  Allows the import to be made in less time, although images will initially be of lower resolution.
- Creating complete pyramid images:
  Created during the import of pyramid images at the maximum resolution possible.

If you are not sure you need all the project images, or there is a large number of them, it is preferable to import in reduced mode. For less images the full mode import does not usually take more than a few minutes. Bear in mind that you can a reduced project into a complete one by using the tool "***Generate pyramids***" which is fully explained in the corresponding section.

Once the required information has been supplied, click ***Next*** to continue the import. The dialog will update, now showing the information regarding external orientations found in the file you specify and in the form they are to be interpreted.

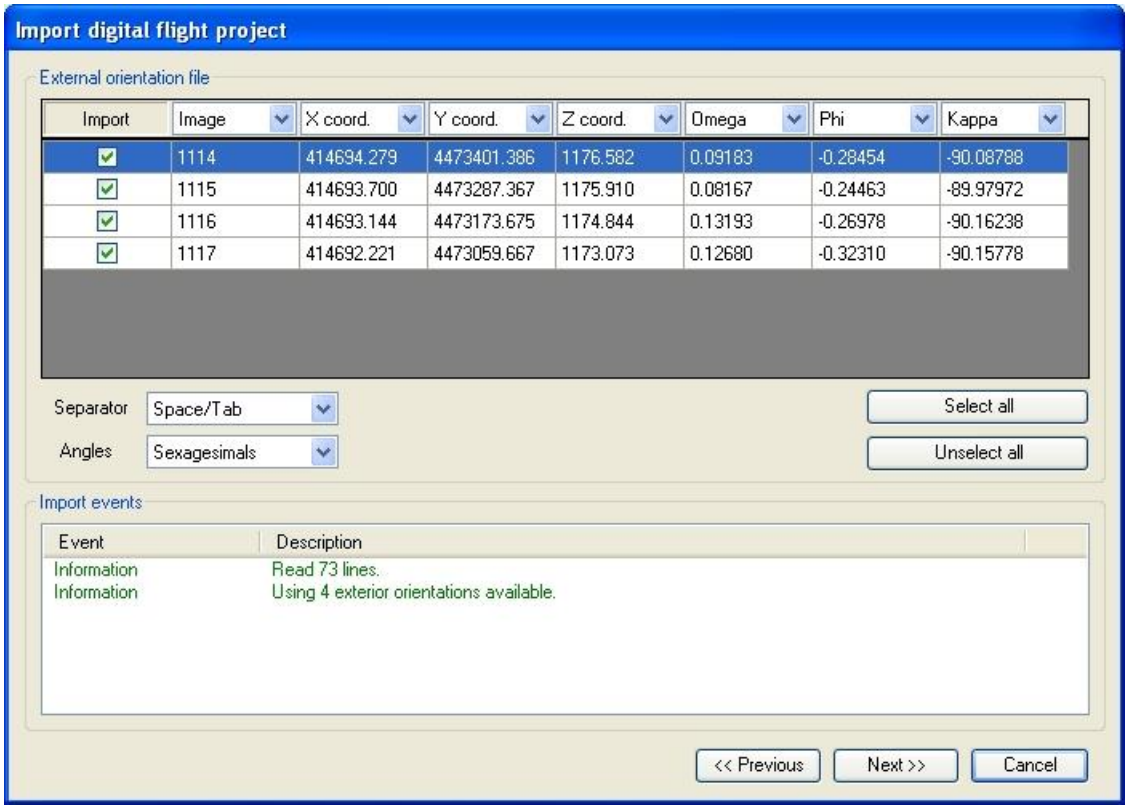


Figure 9 – Import dialog: External orientations.

Note: *Throughout the import process the user will be kept informed of partial results, warnings and errors that might occur, via the table at the bottom of the dialog under the title "Import events".*

The content of the table represents the information read in the external orientations file and interpreted in line with that established in this dialog. By choosing from the options from the

Separator drop-down menu, you can indicate what separator should be used to identify the various fields in the external orientations file. Similarly, if the column headers do not correspond to the content, use the tabs at the top of the table to assign them correctly. It is important that the ***Angles*** drop-down menu represents the angle units used in the columns represented by the rotations Omega (Ω), Phi (Φ) and Kappa (K).

The first column in the table indicates which external orientations are to be imported initially, although subsequently they may not be able to be imported for various circumstances. You may select or deselect all the lines using the tabs provided. Bear in mind at least two consecutive external orientations need to be imported within a strip in order to create a stereoscopic model.

Note: *Throughout the import process, you may go back to the previous strip by clicking on "Previous" or by cancelling the process by clicking "Cancel".*

Once all drop-down values have been correctly set, click ***Next*** to continue the import. The dialogue will update again, now showing the information relating to images found in the file you specify.

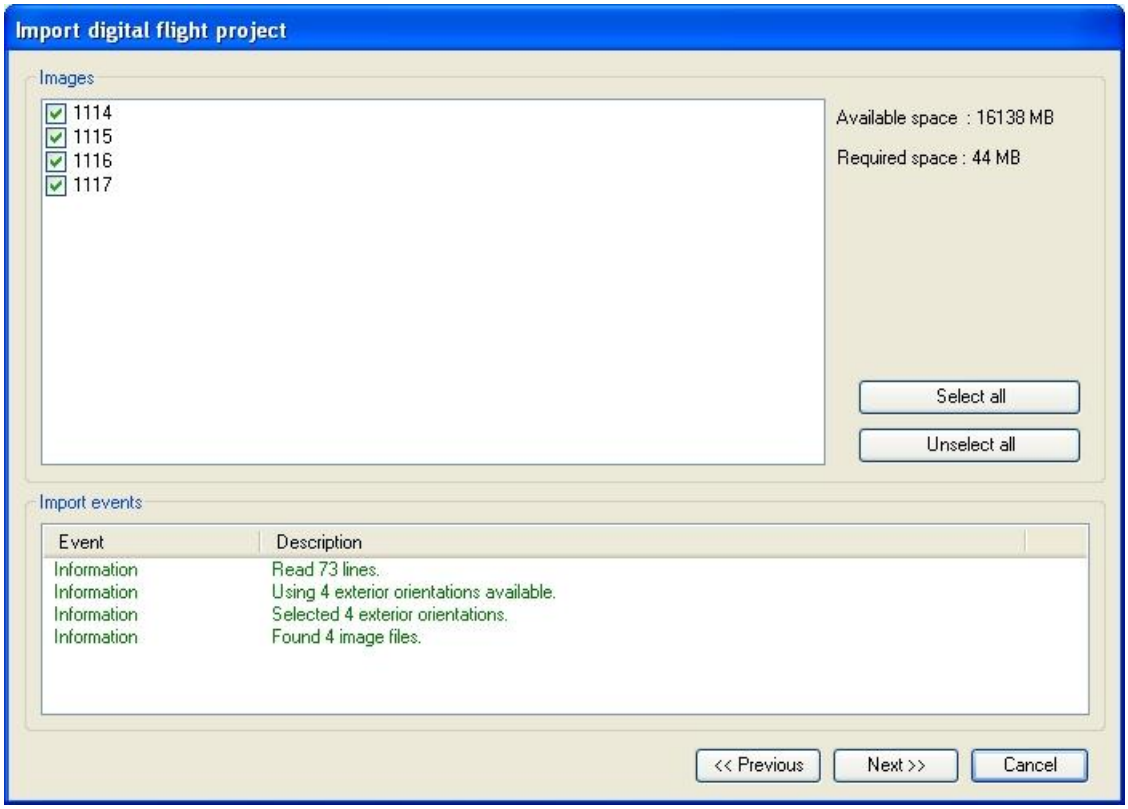


Figure 10 – Import dialog: Images.

A list of images of those that appear in the image file will be shown, enabling the corresponding external orientation to be imported. If an image which is not on this list is detected, check that its external orientation has been selected and that the image is contained in the correct image file.

In the same way as in the previous step, you may select/deselect all the images, or individually check or uncheck the corresponding box in the table. You should consider two questions here:

- That you have selected at least two consecutive images with the same strip, in order to generate at least one stereoscopic model.
- That in the information referring to disc space, the *Available space* value should be greater than the *Required space* value, in order to create the project.

Note: *If the project is imported using the reduced mode, the required space is far less than is needed to import in full mode. If there is the possibility that a large part of the project will later be converted to full mode, take the precaution of ensuring that the project's destination folder in on a disk with sufficient free space. Nevertheless, there is always the option of moving the project to another disc with more free space without loss of information.*

When you have selected the images that you want to import, click ***Next***. Once again, the dialog will update, this time showing the stereoscopic models that can be created.

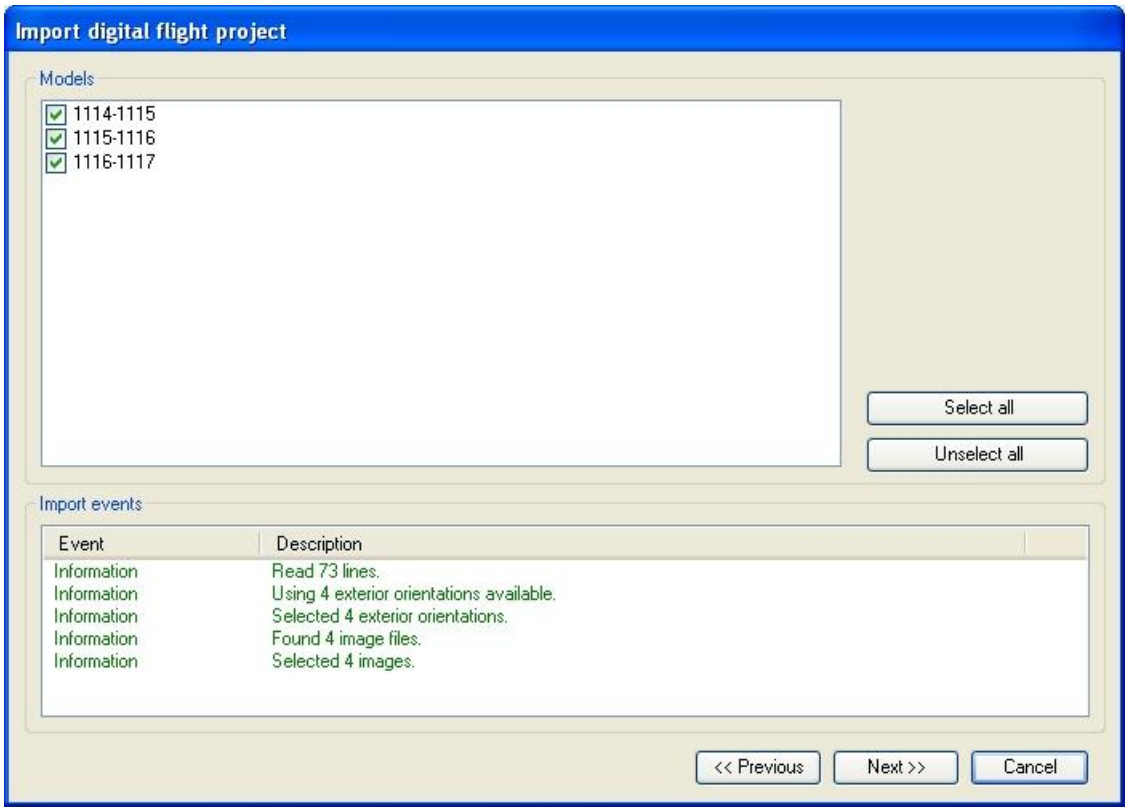


Figure 11 – Import dialog: Models.

You now need to select what models you wish to generate in the import. The logical thing to do is to select them all, as these are the models that can be formed with the orientations and images selected in earlier strips, the amount of information produced is not great and the processing time is insignificant. Having selected the necessary models, click ***Next***. You will now be able to see the relation between the camera and flight parameters. If the process has been correct, you will only need to indicate the average height of the terrain in order to correctly represent the photogrammetric block and stereoscopic models.

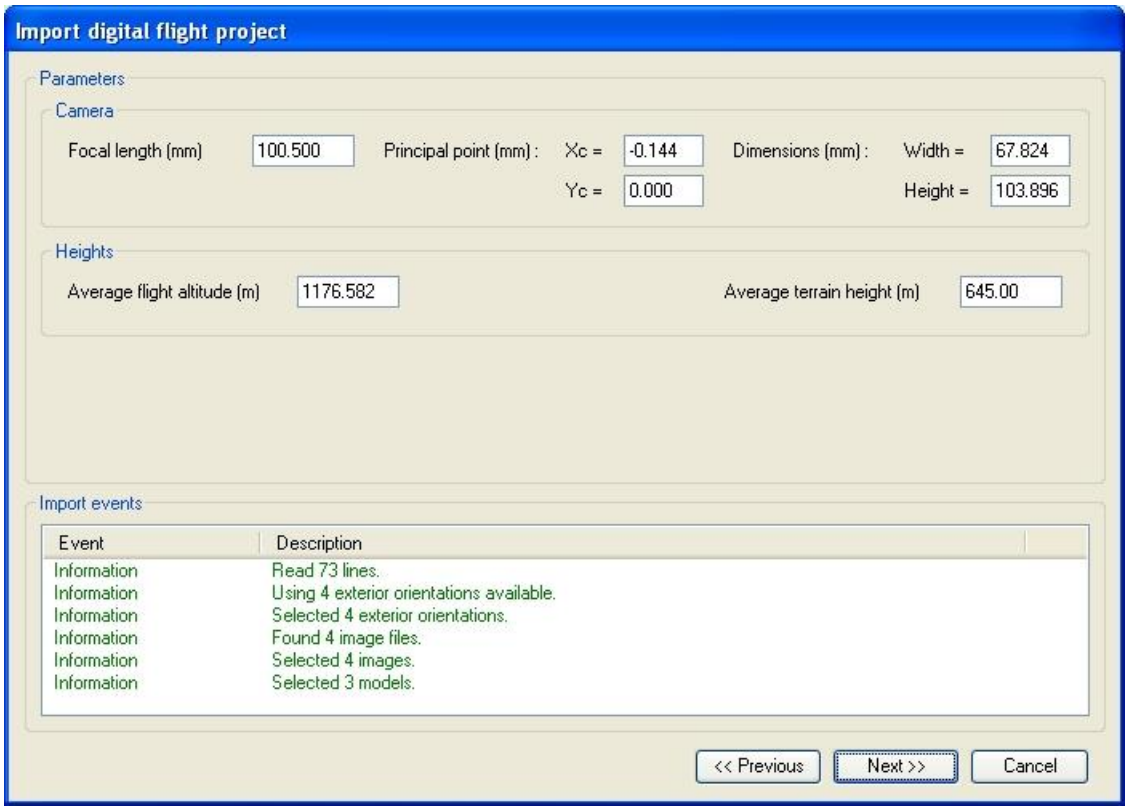


Figure 12 – Import dialog: Parameters.

***Note**: You can check camera values with those shown in the camera calibration report, and see how "Focal distance" and "Dimensions" cannot be zero. The average flight height shown is that calculated based on external orientations of the selected images. The average terrain height should be entered by the user (at least approximate).*

After checking and confirming parameters, click ***Next*** to start the conversion of original images into pyramids and end the import process. You can now see how the dialog changes content, in order to show conversion progress. Three progress bars will appear, corresponding to the conversion progress of the current image, of the current strip and of the project as a whole (all strips).

***Note**: TcpStereo will create strips based on the external orientations, images and models that you import. Strips correspond to images which are consecutive in terms of number and external orientation (photo-center and rotations).*

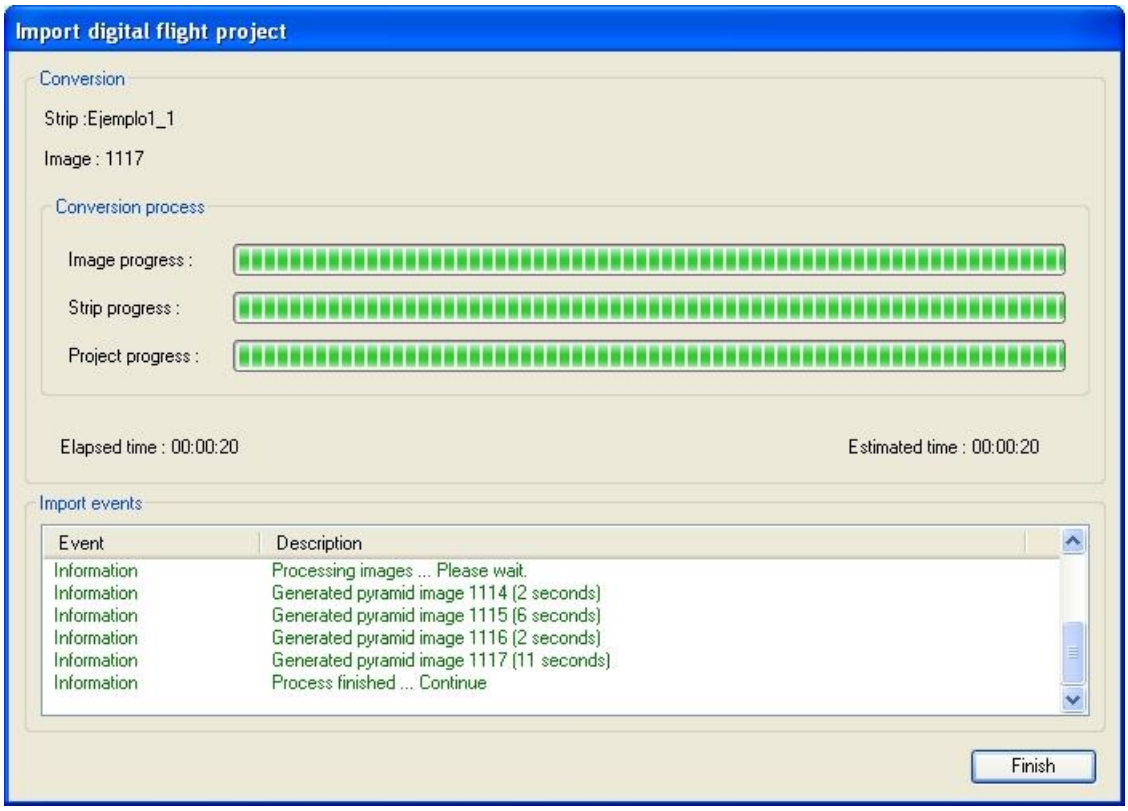


Figure 13 – Import dialog: Conversion.

In the dialog you will also see two tabs which show conversion time and estimated total time. Given the computing cost involved in creating pyramid images it is normal that the time taken bar does not update in real time, although it will update every few seconds. The situation with the progress bars is similar.

Once all images have been converted, the project will have been created and you can click ***End***, concluding the import process and closing the dialog.

Import a Pix4d project

TcpStereo offers this option to import camera data, exterior orientations and images from a Pix4d project.

In order to import this kind of project, use the menu bar with the sequence ***File > Import project > From Pix4d data…*** A folder selection dialog will appear, where you should select the folder of the Pix4d project to import.

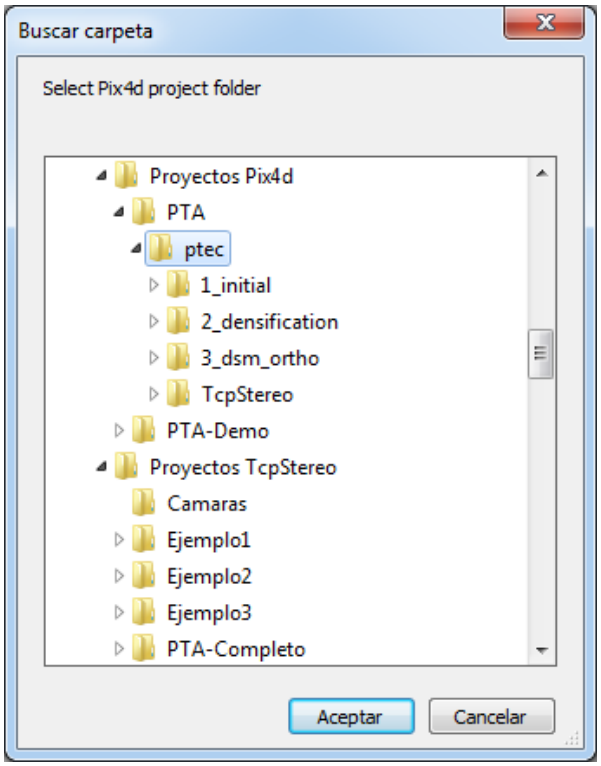


Figure 14 – Folder selection dialog

Once you have selected the required folder, the dialog “Import data from Pix4d” will be shown, with several fields filled automatically. Check these fields to ensure that the files and folders are ok, and set the flight and ground average heights, and the output data options to your preferences, as we did in the digital photogrammetric flight.

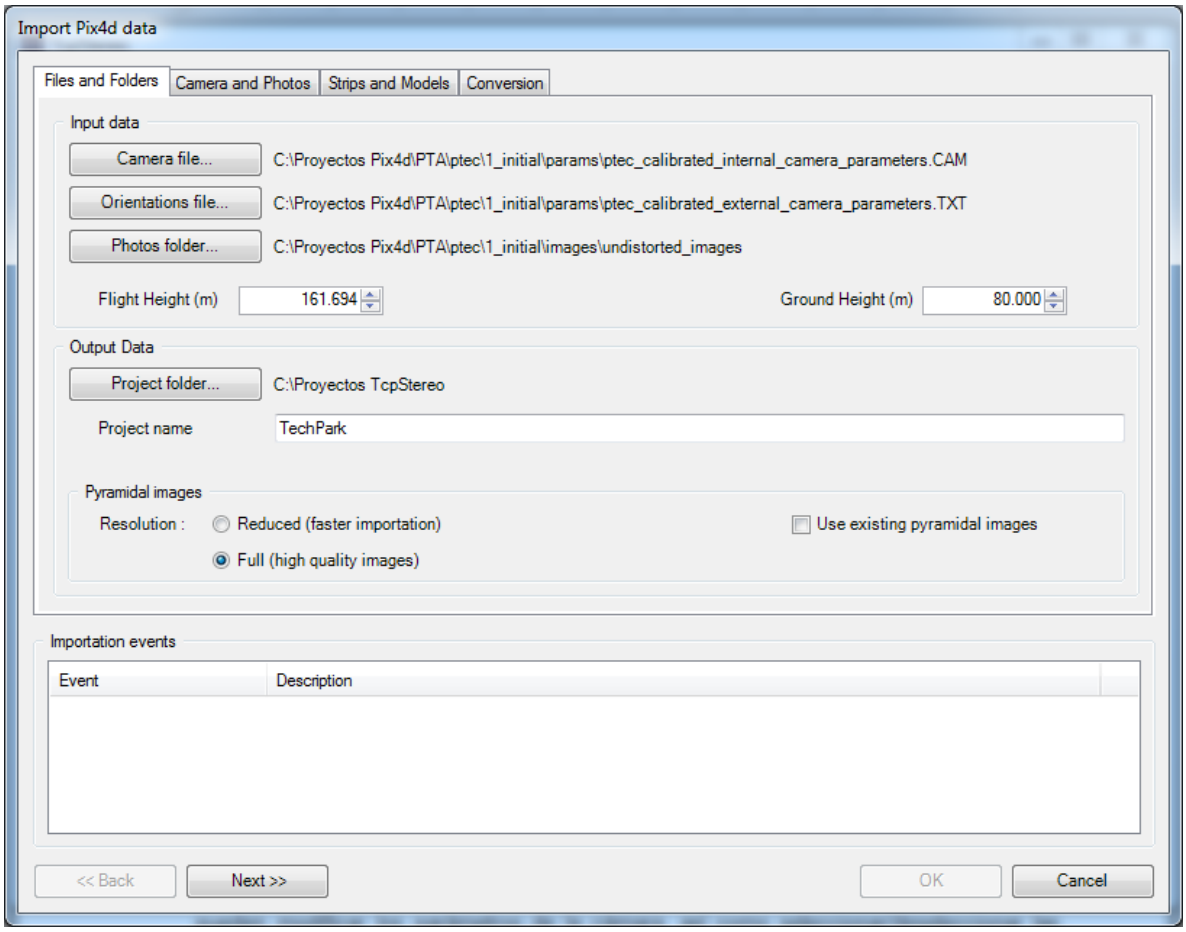


Figure 15 – Import Pix4d data: Files and Folders

Click “Next” to advance to “Camera and Photos” tab, where you can edit the camera parameters and select/unselect the images to import. Do not forget to specify the used angle unit. In the bottom of this dialog you will see info, warning and error messages relatives to the import process and events.

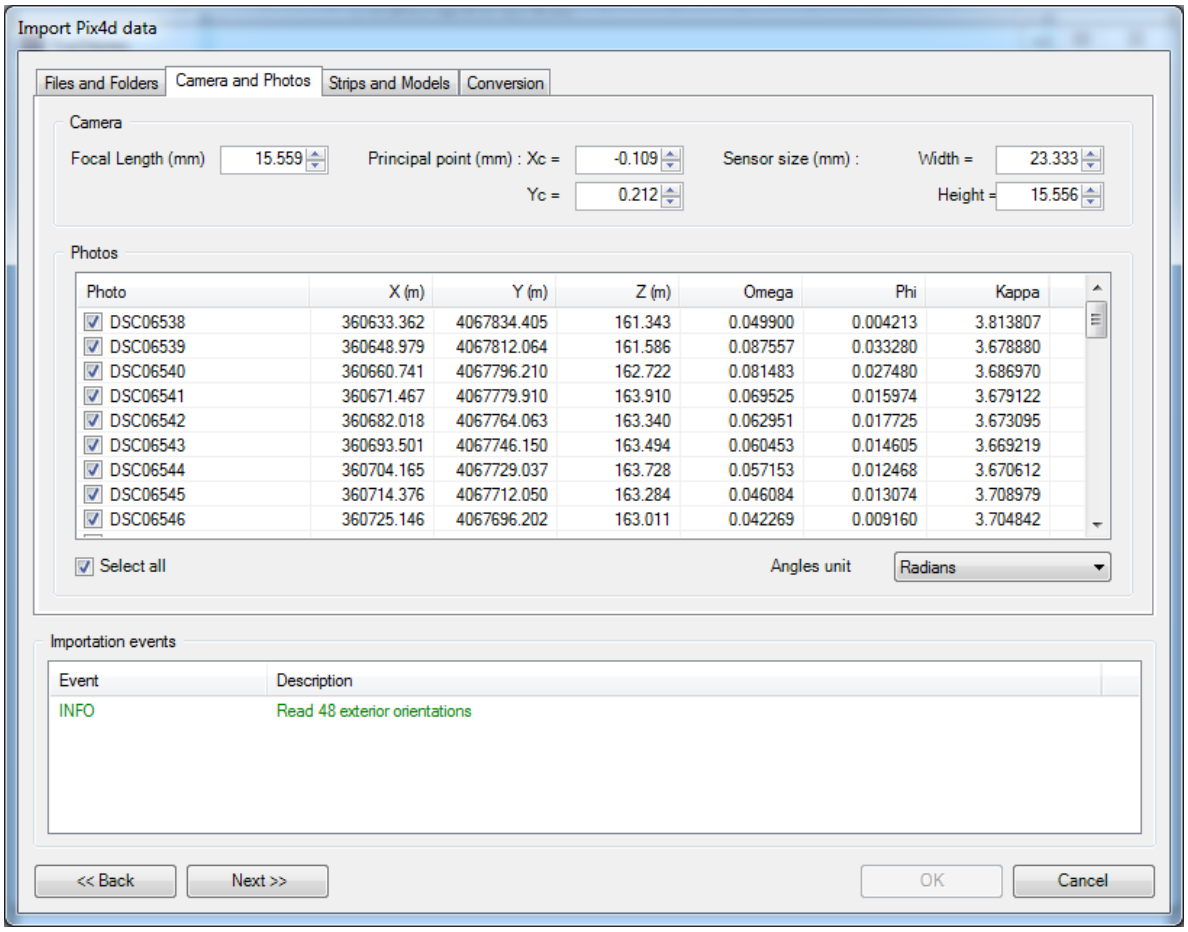


Figure 16 – Import Pix4d data: Camera and Photos

Clicking the “Next” button the “Strips and Models” tab is shown. In the tree of the left side you can check/uncheck the strips and photos you wish import, while in the list on the right side you can check/uncheck the models that will be created based on the strips and photos checked before.

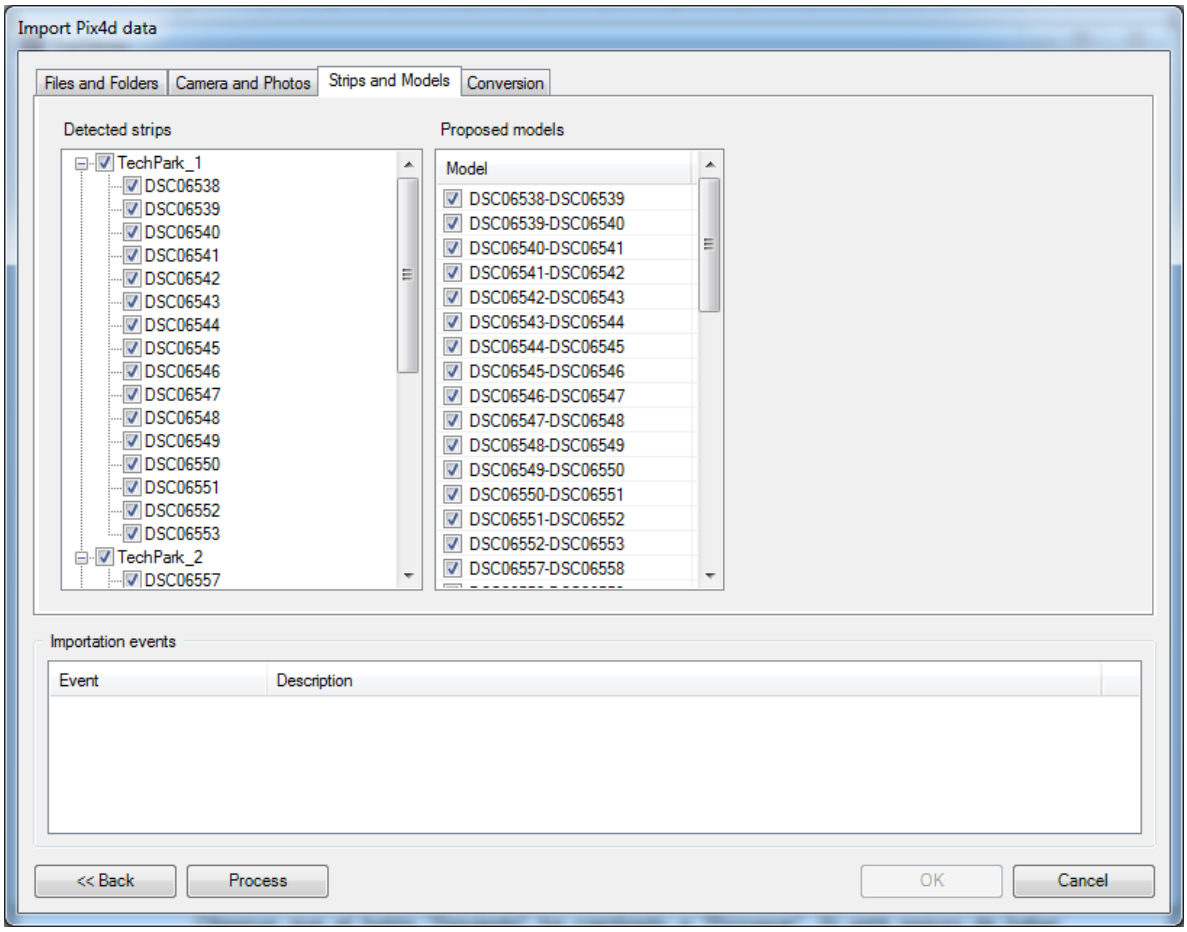


Figure 17 – Import Pix4d data: Strips and Models

Watch that button “Next” changes its text to “Process”. If you are sure that everything is ok, click that button to start the conversion process.

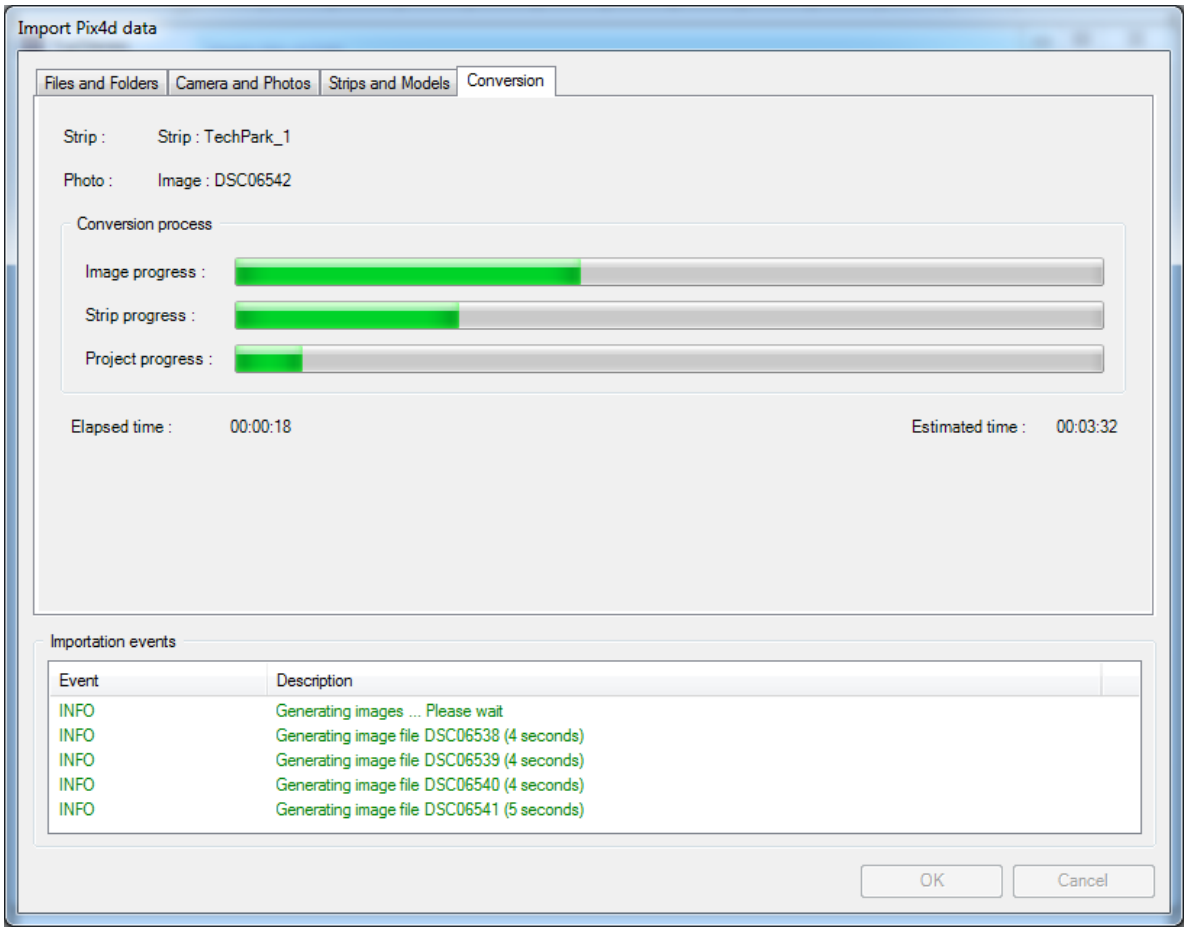


Figure 18 – Import Pix4d data: Conversion

The process will create the pyramidal images from the undistorted images of the Pix4d project, showing the progress for each image and strip as well as the global progress.

Once the conversion has finished, click on the “OK” button and the project block of images just imported will be shown.

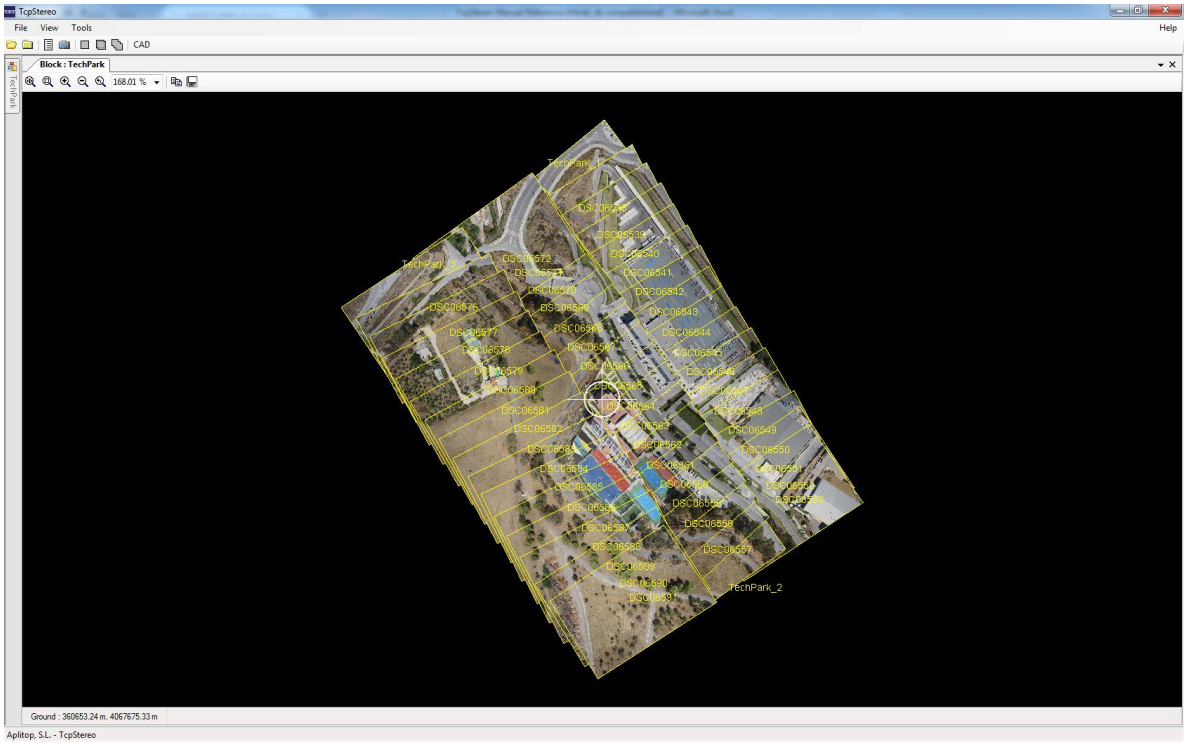


Figure 19 – Import Pix4d data: Block of images

Import a Digi3D project

Use this import option when you have a Digi3D project and external orientation file based on this project and created by Digi3D, or else by a set of files which contains the external orientation of one of the images.

In order to import this kind of project, use the menu bar, entering ***File > Import project > From DIGI3D…*** A dialog box will appear, “Import Digi3D project”, as can be seen in Figure 20.

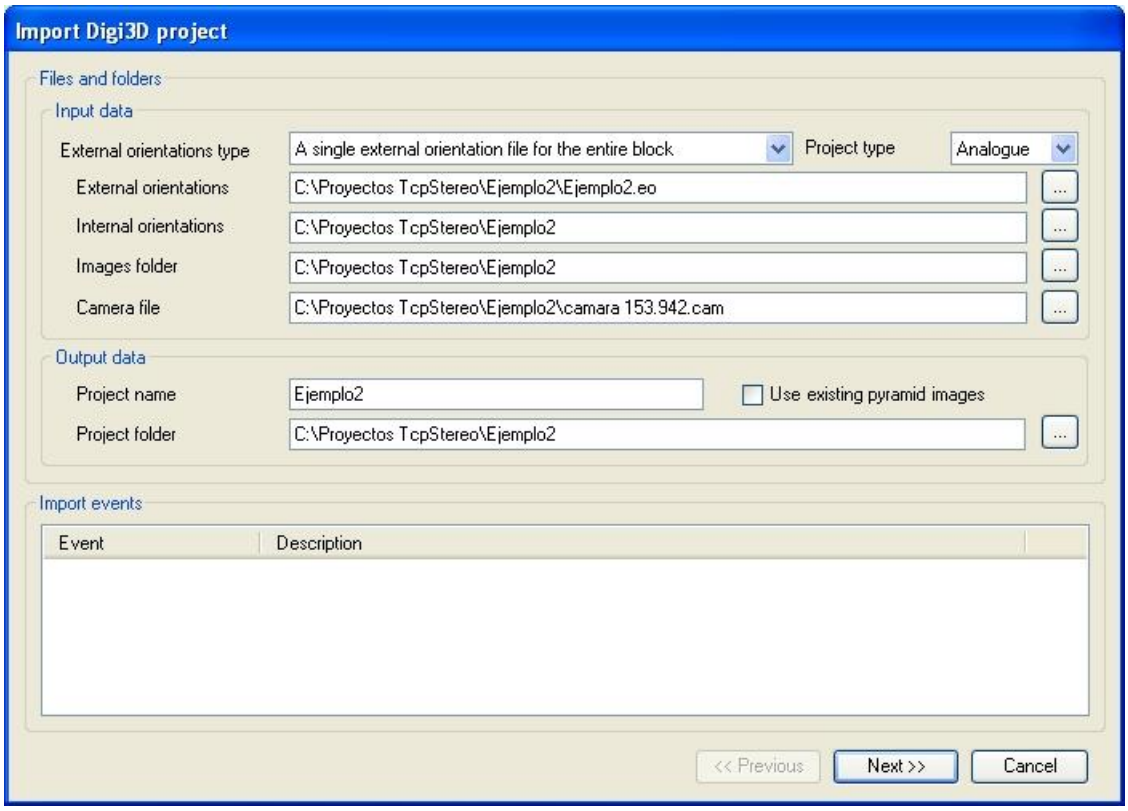


Figure 20 – Import Digi3D project dialog.

Firstly, you will need to indicate how external orientations are to be supplied:

a) In a single external orientation file.
b) In various files, one for each image considered.

You should also indicate if the images are analog or digital photographs. Once this has been done, you need to specify the location of data entry - in other words the file or folder that contains the external orientations, the location of the Digi format(*.in) internal orientation files, in what folder the image files can be found and which file contains the Digi format camera (*.cam).

As was the case when importing digital flight projects, you should also decide what name to give the project and in which folder the information obtained will be saved (ensuring that it has sufficient space).

When importing Digi3D projects complete pyramid must always be created.

Note: *When importing both digital flight projects and Digi projects using the full mode, a dialog box will appear: "Use existing pyramid images". If you check this box and the folder "Images" folder for the project already exists and contains pyramid images (*.mpt) which coincide with those you wish to import, they will be taken from the folder, without the need to create them again.*

Once the required information has been supplied, click ***Next*** to continue the import. From here on, the steps are exactly the same as those explained in the flight data project import section. It is important to confirm that the parameters before conversion are correct, and establish the average height of the nearest terrain.

3.1.3. REDUCED AND FULL MODES

Projects imported from digital flight data in reduced mode can be shown in two ways, in reduced mode with reduced images or in full mode, with images from which pyramids can be generated. In order to change from one mode to the other, use the tab Reduced mode/Full mode on the right of the tool bar.

When you change from reduced mode to full mode, a dialog box will appear to remind you that there are still images which may be converted into complete pyramids, giving you the option to convert it at that moment.

Figure 21 – Full mode dialog box.

You can also create complete pyramids via the main menu - ***Tools > Create pyramids***. There is further information on this matter in the corresponding section.

Once pyramids have been created from all the images in a project initially imported as reduced, the project will always be shown in the full mode, and the change mode option will no longer appear in the main tool bar.

3.1.4. PROPERTIES

The properties of a project that is currently open in TcpStereo can be easily checked, using the menu bar - ***File > Properties…***

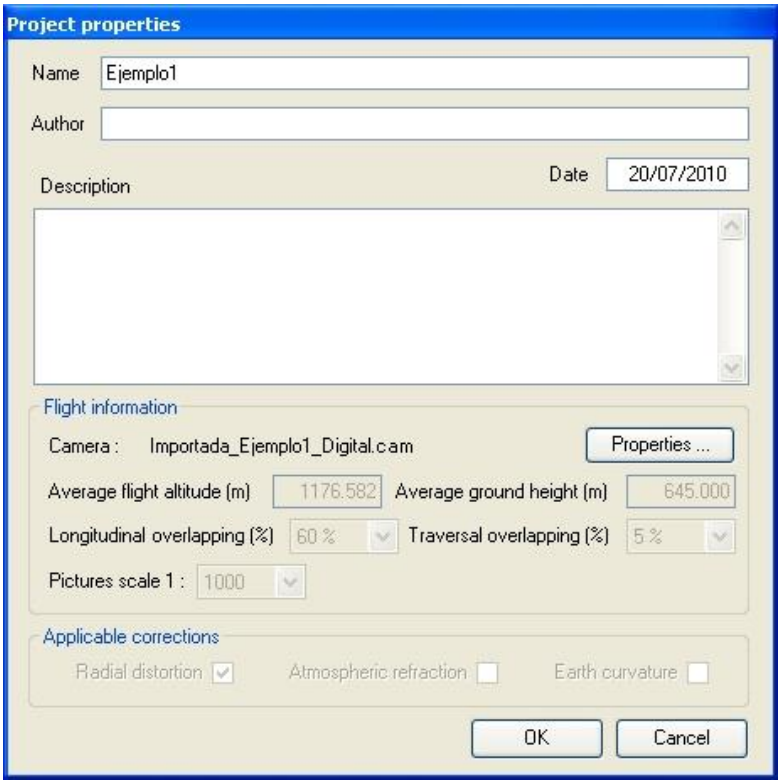


Figure 22 – Project properties.

This shows information relating to the project (non-editable), as well as data provided by the program, which has no bearing on application operations. Via the tab ***Properties…*** in the box *Flight information* you can access the parameters of the camera used in the project.

You can also access project properties via the tab ***Project properties*** from the main tool bar. Camera properties are also directly accessible via the tab ***Camera properties*** on the main tool bar.

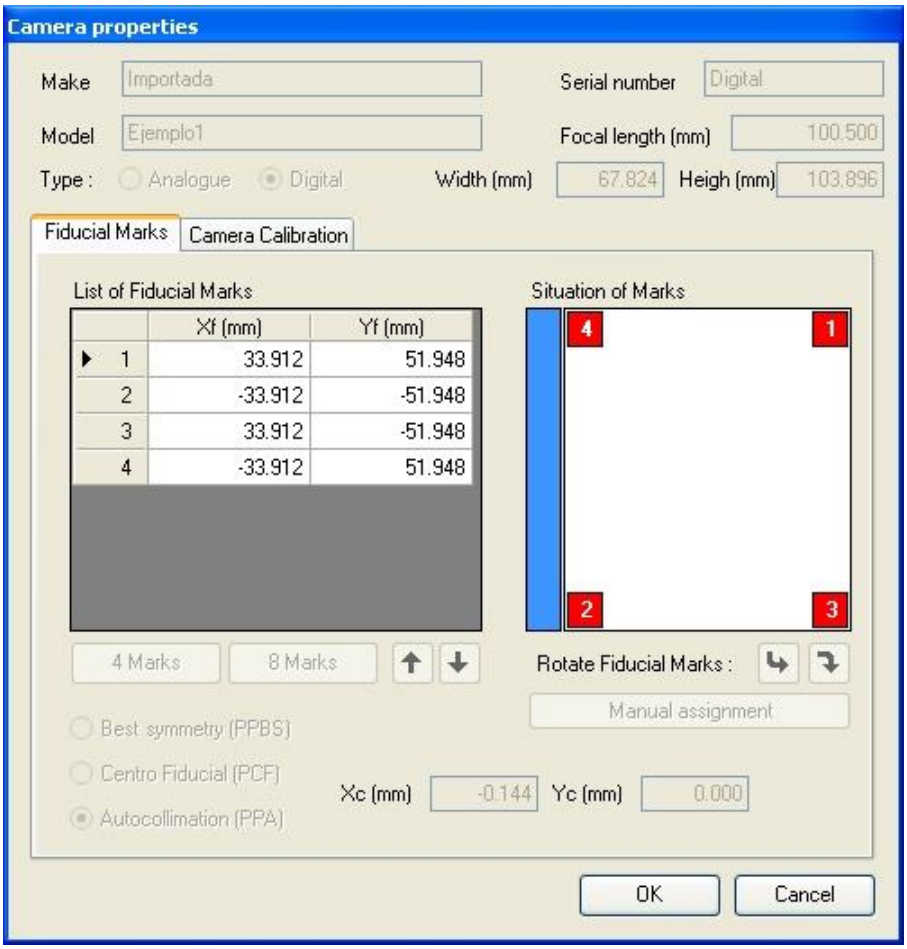


Figure 23 – Camera properties.

Camera properties are also editable, and reflect the parameters obtained during the project creation process (import). Among other aspects it shows if the camera is analog or digital, the *Focal distance* values, *Image dimensions* (format), fiducial coordinates and the center.

Note: *The information shown in properties is only for consultation purposes - once a project has been created it cannot be modified. Certain information fields are included in order to provide compatibility for future development and application improvements.*

3.1.5. STRIPS, MODELS AND IMAGES

When you load a project, on the left-hand side of the screen there is a tab with the name of the current project. If you move the cursor over this tab you will see a strip and model control window.

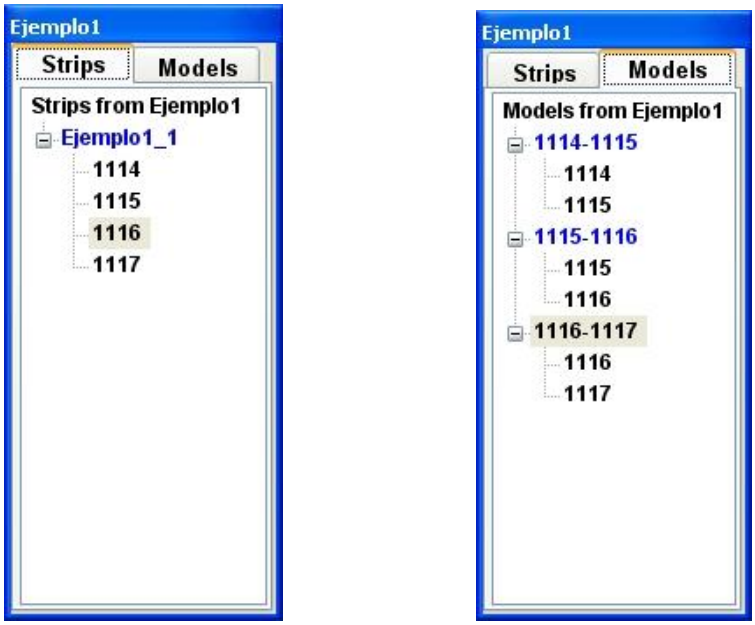


Figure 24 – Strip and model control window.

Clicking on the “thumbtack” on the top bar allows you to set this window so that is no longer visible, or free it so that it is automatically hidden when the window is no longer active. If it is set, you can drag it by left clicking on the top bar, and either leave it as a floating window or anchor it to one of the margins of the program's main interface. In either case you may resize the frame by dragging its edges.

In this window or control menu there are two tabs, one corresponding to strips, the other to models. As its name suggests ***Strips*** allows us to see how the project has organized the strips, with the images included in each strip, whilst the tab ***Models*** shows the project's models and the images it consists of.

The image and model elements of this window can be selected by left clicking which brings up a series of options which can be chosen by right clicking.

One of the options available is seeing the properties of the element in question. In the case of images, by right clicking on an image element and then selecting the option ***Properties…***” you will see a dialog box that shows information regarding the image file, and its internal and external orientations.

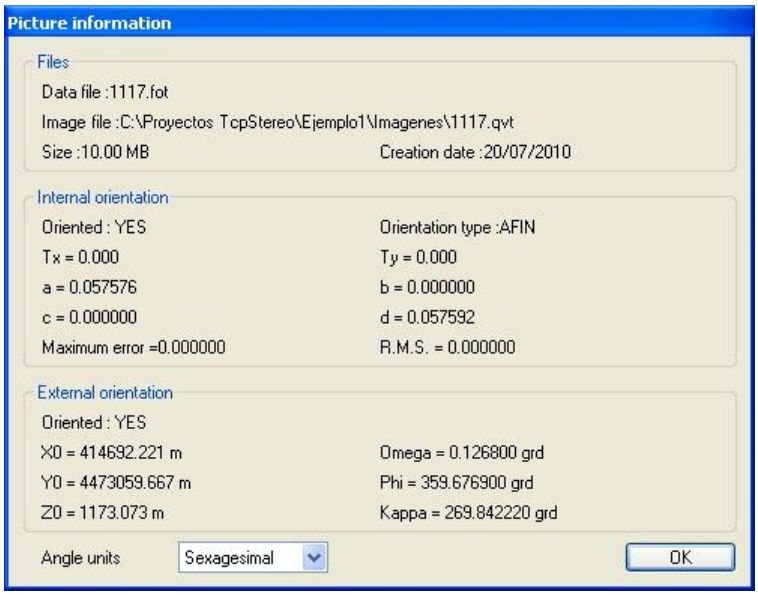


Figure 25 – Image/photograph properties.

Similarly, in the case of models, you can select ***Model properties…***"

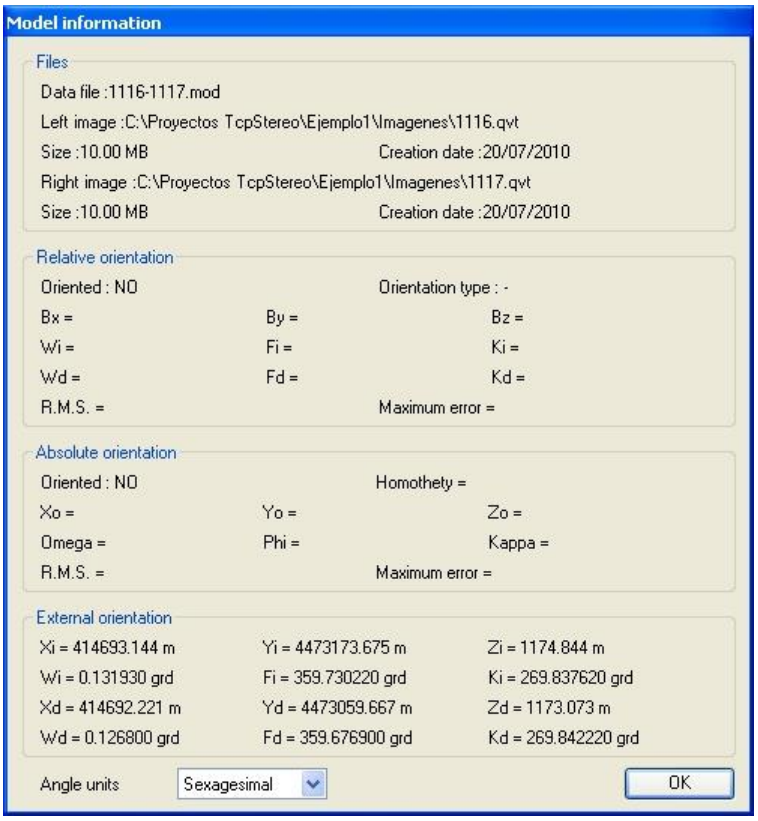


Figure 26 – Model properties.

In the case of models, the properties shown relate to the image files that make up the model, along with external orientations. You can also see information referring to the model's relative and absolute orientations. This information is not relevant to the user although it can be applied to future extensions to the software and its compatibility with other programs - it is therefore not necessary to explain its meaning here.

The selection of an image or model in the control window means that this element becomes the current image or model, the consequences will be seen in the next section dealing with visors. As a foretaste we can say that some menu bar and main tool bar options are based on the current element, which will be the object of the actions to be taken.

Further information regarding external orientation of all project images can be found at ***View > External orientations*** from the main menu.

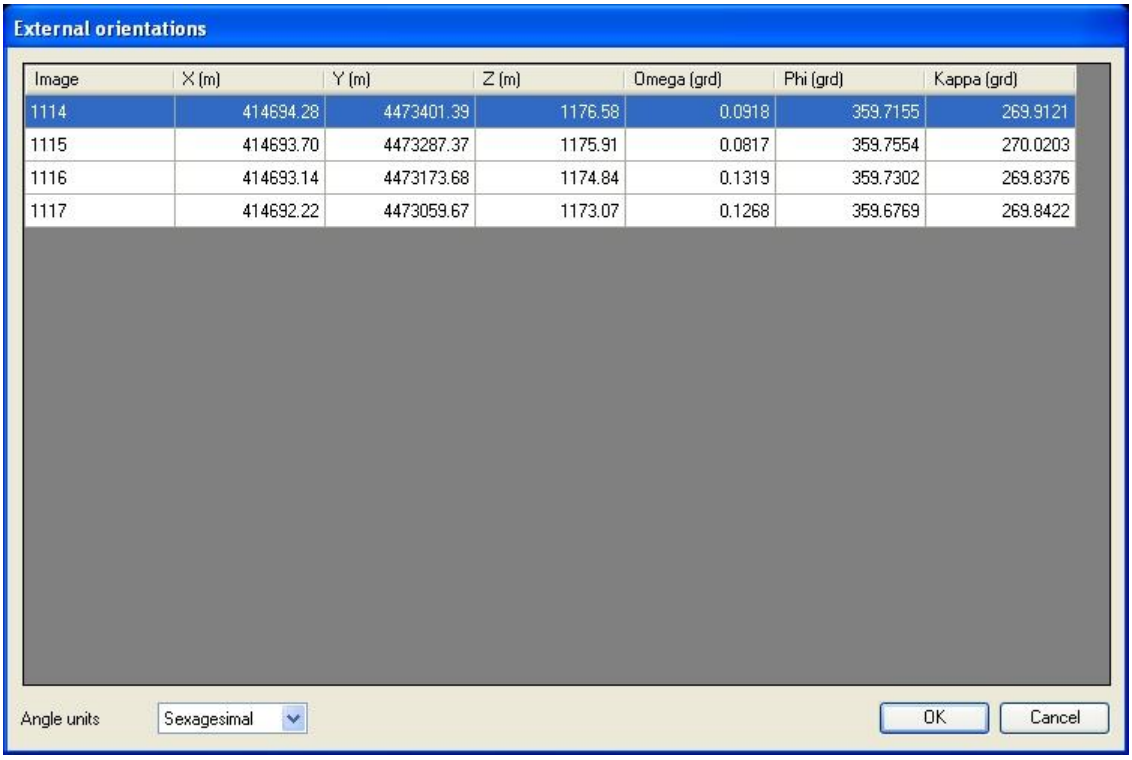


Figure 27 – List of external orientations.

Each row of the table shows the external orientation of an image. The first column corresponds to the image number. The three following fields show the photo center's X, Y and Z coordinates - the three last values correspond to the camera's omega, phi and kappa rotation angles. These should be angularly equal or equivalent to values read from the external orientation file/s of the specified images during project import.

Via the ***Angle units*** drop down menu you can select on which units you wish the tables rotation angles to be shown.

The strip control window can also be used to hide strips. This will have two consequences: the first is that hidden strips will not appear on the block viewer. The second is that on establishing automatic model change, only those models from ***non-hidden*** strips will be changed. This allows you to work with a subset of photogrammetric flight strips.

3.1.6. CAD TOOL

We are taking CAD tool to mean AutoCAD 2004 – 2016 and Bricscad v9 to v15 software which you will have installed on your computer and configured in TcpStereo as “CAD Version” (see ***Customization***) - the CAD program you will be using to draw in from TcpStereo. Once you have opened the project and established a specific CAD program,

click ***CAD*** on the main tool bar in order to connect with the CAD application. If this program is already running, TcpStereo will automatically connect to it. If not, it will launch it and a few seconds later which are needed to start up the application, TcpStereo will connect to it. If there is any problem, the corresponding message will appear, or the program will not connect to the CAD.

You need to have had the CAD program installed prior to installing TcpStereo to ensure a correct connection, given that the installation process sets up for the various CAD programs it detects in order to communicate with TcpStereo.

On connecting to the CAD, you should see a CAD control window, as shown in Figure 28:

Figure 28 – CAD control window.

This window has three elements that control some aspects of the application:

- Option ***Auto centered*** → CAD monitoring is always centered.
- Tab ***Layers…*** → Shows the layer selection dialog to be shown in TcpStereo models.

For a better understanding of this area, please see the section that refers to CAD toolbar on the model viewer.

Note: *When there is a communication problem between TcpStereo and the CAD application it connects to, the user will ne notified via a dialog box. Check that the CAD control window is visible and cancel any open command in the CAD program.*

3.2. VIEWERS

The term "viewers" refers to the three types of window that allow us to see project images in different ways:

- Block viewer: All project images together.
- Image viewer: Each project image in an individual manner.
- Model viewer: Pairs of images that form models.

Each viewer features one or more toolbars which allow us to undertake a series of actions in order to control the viewer or access an additional function. Interaction with all viewers is via your mouse and keyboard (See the section **Customization** to see how to set up the keyboard).

3.2.1. BLOCK VIEWER

The block viewer shows all project images, arranged as a mosaic and positioned depending on their respective external orientations and flight parameters. The block viewer appears immediately after opening or importing a project.

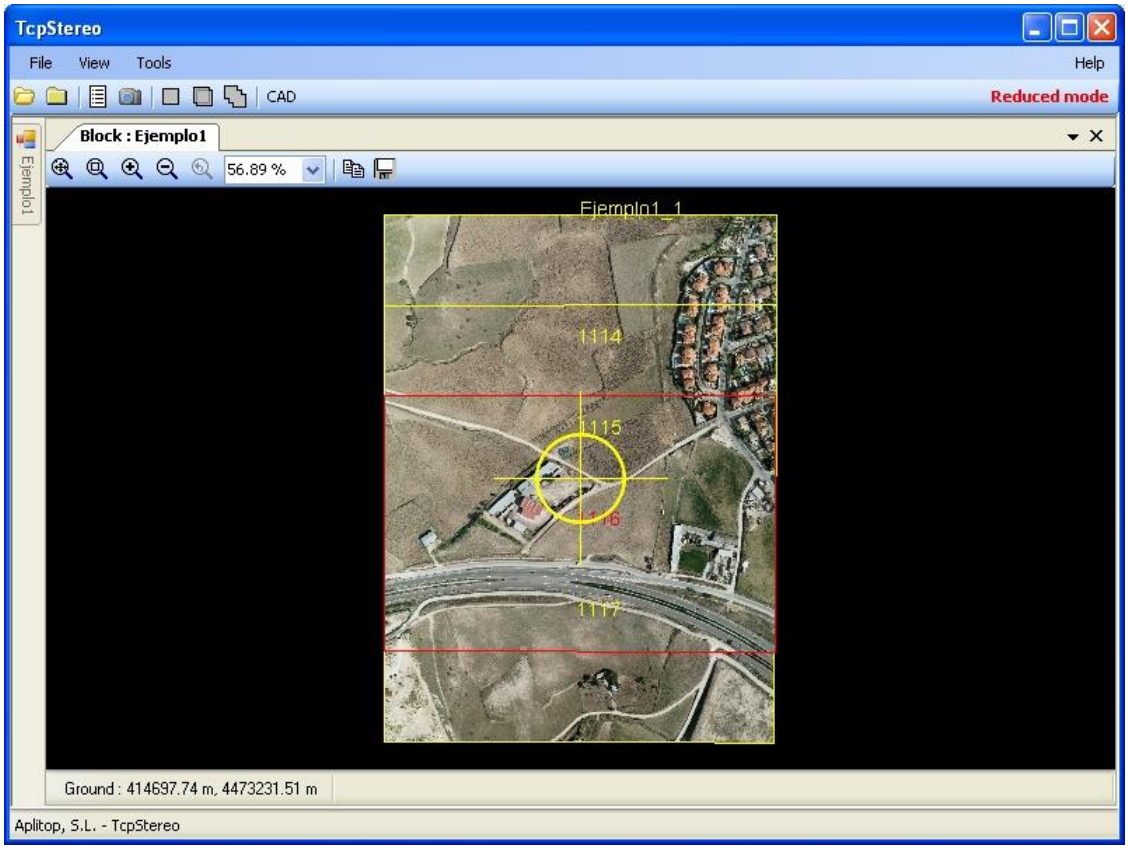


Figure 29 – Open block viewer.

This viewer can be closed by clicking on X in the top-right corner, and can be brought back via the menu bar - ***View > Block*** or via the tab ***Show block*** on the toolbar.

Block viewer control using mouse and keyboard

The basic block viewer actions are:

a) Offset: To offset the viewer, left click on viewer content and drag using the mouse. The viewer will move correspondingly. You may also offset the viewer by using the offset keys configured to this end (see the section **Customization**).
b) Scale / zoom: You may increase and decrease scale and zoom by using the scroll wheel on the mouse, turning it back and forth. You may also use the zoom keys which have been set up for this.
c) Selection: To select an image from the mosaic and bring it to the front, you just need to left click on the number of that image. The current image is profiled in red, whilst others are profiled in yellow.

Note: *See how on selecting an image in the block viewer, it is shown as selected in the strip and model control windows. Similarly, if another image is selected in the window, this will be shown as the current image in the block viewer, coming to the front. You can therefore order photos in the mosaic through the selection of the various images.*

Block viewer toolbar 

This consists of a set of tabs whose functions are, from left to right and separated by function, as follows:

1) Display functions:
   - Zoom extension: sets the scale to the maximum possible value in order to show the whole block adjusted to viewer dimensions, varying the cursor position.
   - Zoom window: allows the user to select a rectangle within the current display enabling changes to scale and position in the selected area.
   - Zoom in: increases scale whilst maintaining position.
   - Zoom out: decreases scale whilst maintaining position.
   - Preview zoom: allows the user to return to earlier displays (scale and position) which change when any zoom operation is undertaken.
   - Drop down scale menu: shows the current scale at any point, allowing the user to select a predefined scale or assign an arbitrary scale via the keyboard.
2) Image functions:
   - Copy to clipboard: saves the current display in the clipboard, allows you to cut and paste using any application capable of accessing the clipboard.
   - Save image: allows the user to save the current display in an image file, in BMP, JPG or TIF format.

The block viewer features a status bar at the bottom of the viewer, showing the approximate planimetric coordinates which the cursor moves over.

3.2.2. IMAGE VIEWER

The image viewer always shows the current image. There are a number of different ways that you can open the image viewer in order to show a specific image:

a) By selecting the image and clicking on ***View > Image*** on the menu bar.

b) By selecting the image and clicking on ***Show image*** on the toolbar
c) In the control window, right click on the name of the image and selecting the option ***Show image***.
d) In the control window, double left click on the image name.

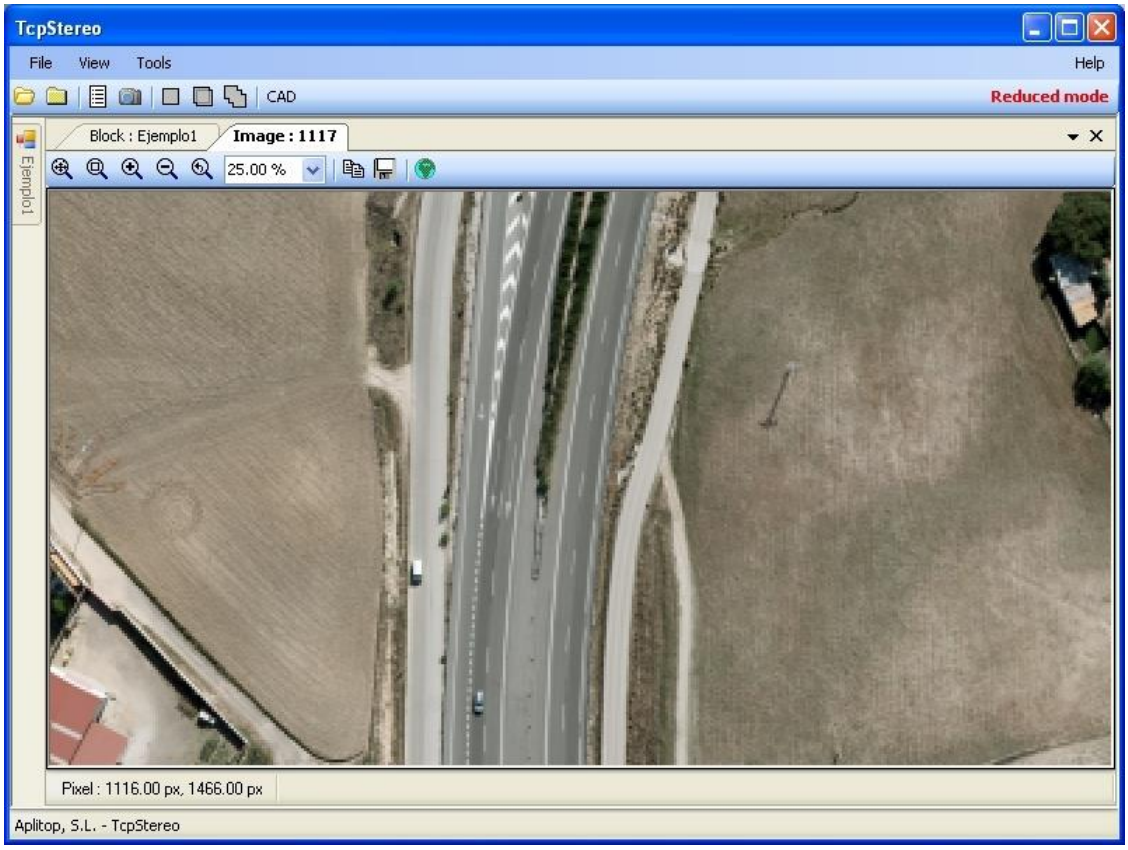


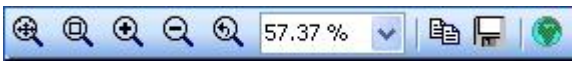
Figure 30 – Open image viewer.

Image viewer control using mouse and keyboard

The image viewer is controlled in the same way as the block viewer, with two differences due to the fact it contains a single image:

- They do not allow offsetting beyond the limits of the image.
- There is no need for selection as there is only one image.

Image viewer toolbar



The image viewer toolbar is the same as on the block viewer (the same tabs and functions), with the addition of a new tab ***View minimap***".

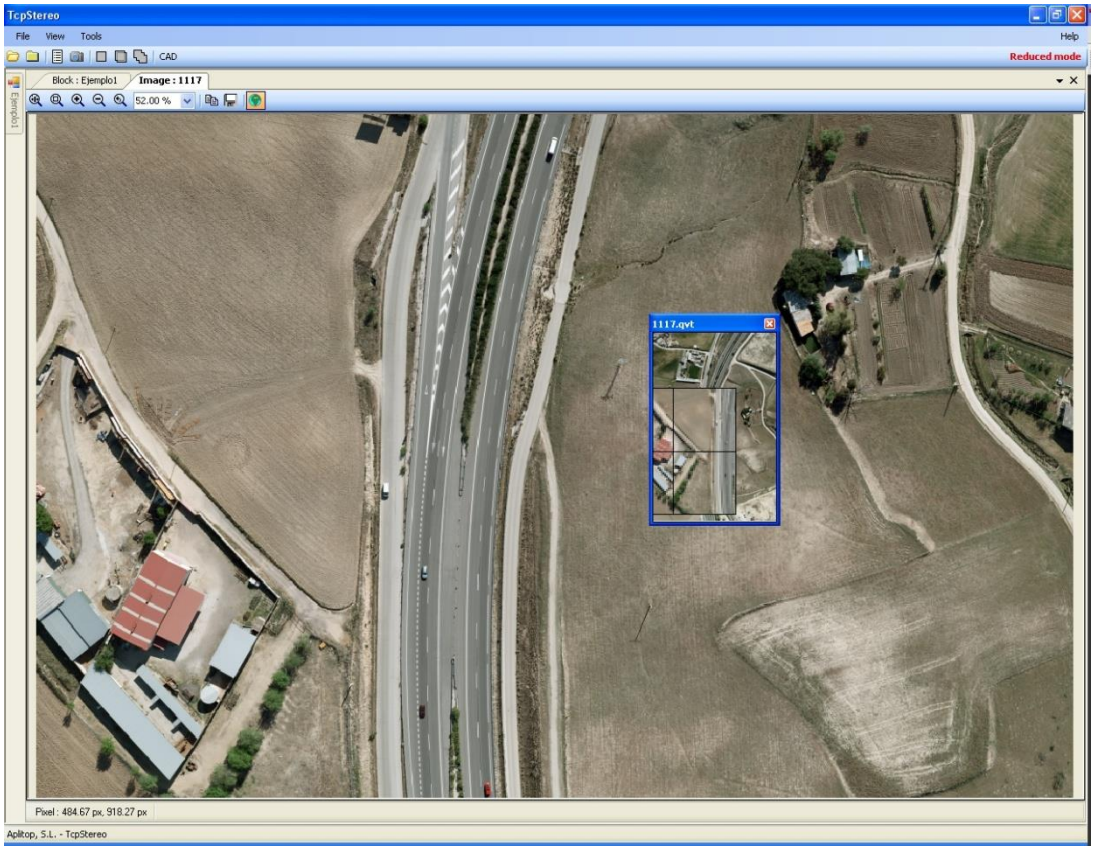


Figure 31 – Viewer with minimap.

The minimap is a small window that shows the same image shown by the viewer (in full form), allowing the user to rapidly establish viewer position on a specific area by left clicking on an section of the minimap. It also shows a rectangle that represents the area currently shown by the image viewer.

The image viewer features a status bar at the bottom of the viewer, showing the pixel coordinates which the cursor moves over or is centered.

3.2.3. MODEL VIEWER

The model viewer always shows the current model. There are a number of different ways that you can open the model viewer in order to show a specific model:

a) By selecting the model and clicking on ***View > Model*** on the menu bar.
b) By selecting the model and clicking on ***Show model*** on the toolbar.
c) In the control window, right click on the name of the image and selecting the option ***Show model***.
d) In the control window, double left click on the model name.

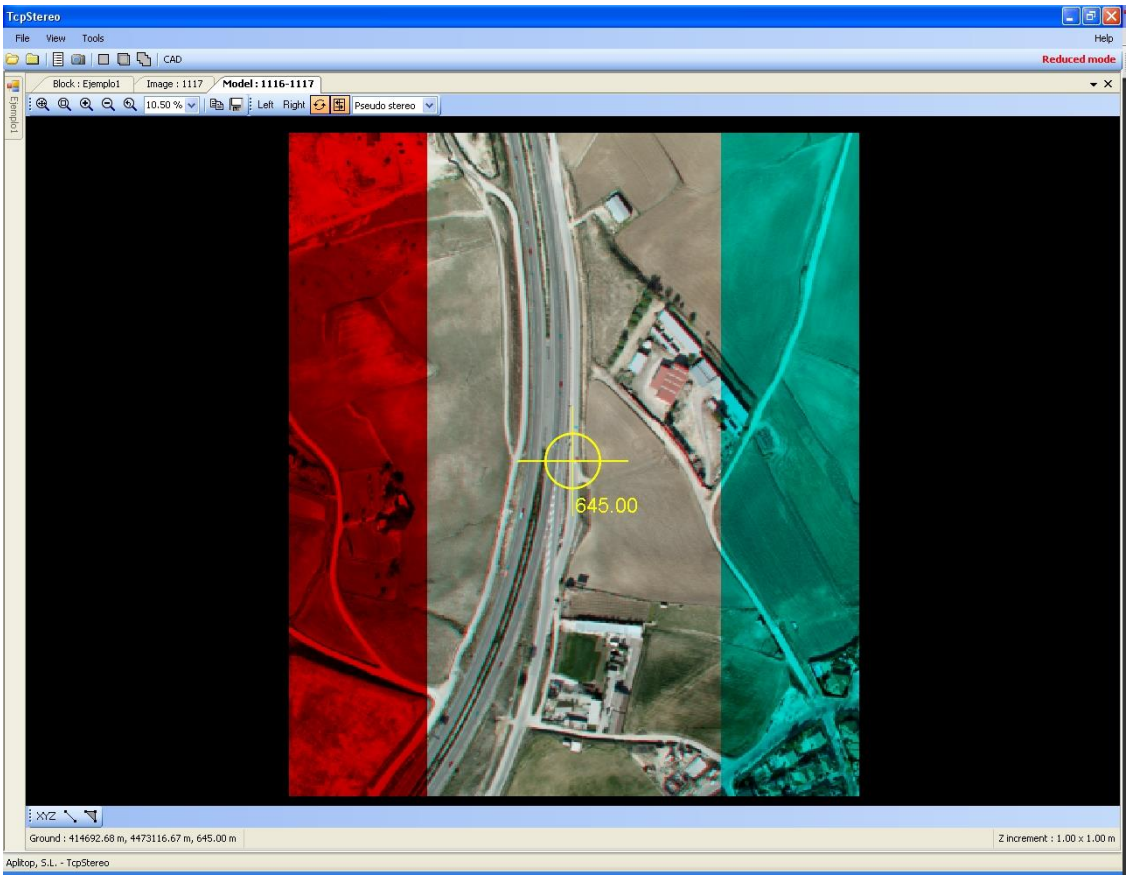


Figure 32 – Open model viewer.

Model viewer control using mouse and keyboard

The model viewer is controlled in a similar way to block and image viewers, except in this case the models are shown in three dimensions. The scroll wheel on the mouse is therefore not used to control zoom/scale, but to control height and elevation (the Z axis value). This elevation value can also be controlled using the keyboard (see the ***Customization*** section).

The model viewer has many more functions on its toolbar than the other viewers, meaning that there are a series of considerations regarding viewer control which will be explained in detail within each available function.

Model viewer toolbar

The model viewer has up to four different toolbars, described below. It is important to understand the role of each toolbar, as their correct use allows you to get the most from the program.

a) Scale/zoom control bar: 

Covers the zoom functions and saves images displayed earlier:

- Extension zoom → View the whole model.
- Window zoom → View a selected part of the model.
- Zoom in → Move in, increase zoom.
- Zoom out → Move out, reduce zoom.
- Previous zoom → Return to the previous position and scale.
- Exact zoom → Establishes a specific zoom factor.
- Copy to clipboard → saves the current display on the clipboard.
- Save image → Saves the current display as an image file.

b) Stereo control bar: 

This toolbar allows the user to control the way in which the stereo viewer is displayed. From left to right, this allows the user to:

- Show/hide the left-hand image.
- Show/hide the right-hand image.
- Rotate the model 180º → Invert the display.
- Invert/swap eyes → Swaps the image seen by each eye.
- Enable/disable stereo: two ways to show the model.
  Pseudo-stereo → Both images are seen by both eyes, translucently. By using this option it is possible to see the image in stereo, via anaglyphs.
  Real stereo → Shows an image for each eye, for the rest of the stereo vision systems.
- Automatic Snap → Using cross correlation, the application tries to set the cursor height at ground level.

c) Geometric function toolbar: 

The geometric function toolbar offers three tools which, from left to right, permit the following:

- Situate the display on specific XYZ coordinates.
  By clicking on the corresponding tab, a floating window will appear - ***Terrain coordinates***, which allows you to set the exact coordinates.

You can enter a value for each coordinate and click on ***Situate*** so that the model viewer situates in this position, or else enter one of the values and click Enter.

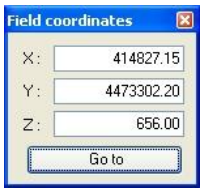


Figure 33 – terrain coordinate window (XYZ).

- Measure 2D and 3D distances.
  By clicking on the corresponding image, the model viewer enters into a special control mode which we shall call “Blocked mode”. In this state, the central viewer cursor moves as you move the mouse, without having to click on the mouse. The left mouse button is now used to designate points on the model, which correspond to the vertices that define the polyline segments from which the length will be calculated. Once all the required points have been thus marked, right click to finish.

Note: *The status bar at the bottom of the model viewer shows both the current terrain coordinates and the results of certain operations. You will see that when using the distance or area measurement tools, this bar will show the results from these measurements. On the right of the bar it shows a series of values that refer to the Z increase. These values refer to the extent to which the elevation varies each time that the user moves the scroll wheel. Refer to the* ***Customization*** *section for more information on this matter.*

- Measure 2D and 3D perimeter and area.
  On clicking on the corresponding tab, the view finder enters into “Blocked mode”, and, as in the case of the previous tool, you can designate points by using the left mouse button and conclude the operation with the right mouse button.

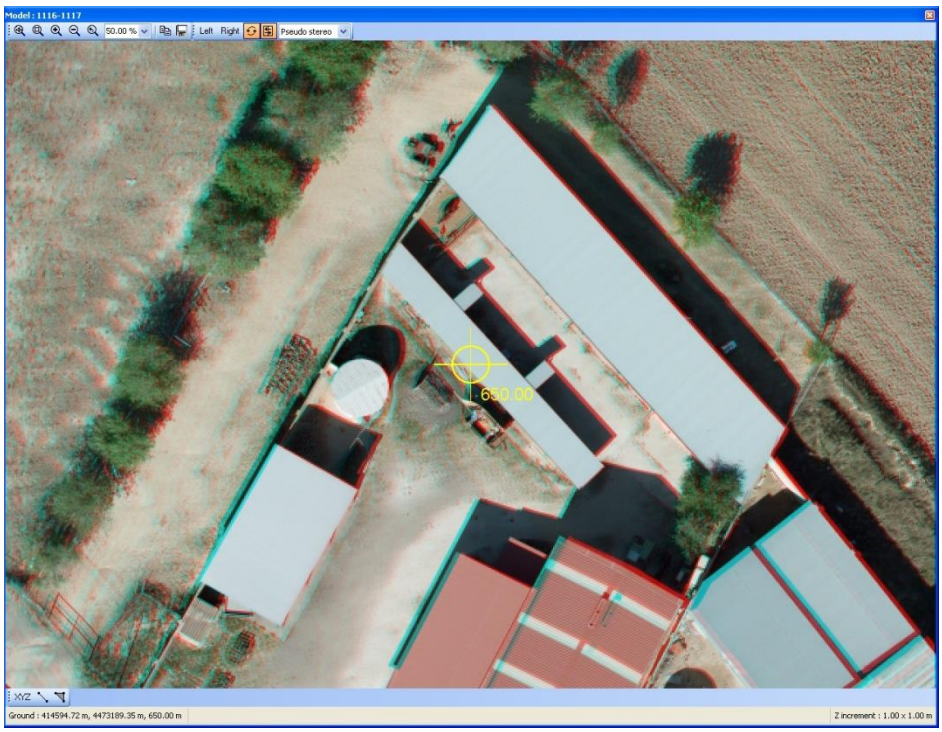


Figure 34 – Model viewer, area measurement tool.

The “Measure distance” and “Measure area” tools work in a similar way, with the latter being an extension of the former in the sense that it calculates the distance which

corresponds to the length of the closed polyline, as well as calculating the 2D surface area contained in each polyline.

d) CAD function toolbar:

This final toolbar is possibly the most powerful, as it allows the model viewer to communicate with the external CAD program to which TcpStereo is connected. The toolbar is not visible in the viewer until TcpStereo successfully connect to the CAD application entered at set up.

The following are the functions and information which feature on the toolbar, from left to right, as with earlier toolbars, here grouped together based on function:

Representation functions:

- Synchronize CAD → Allows the rest of the CAD toolbar functions to be enabled/disabled. Among other things, ensure that movements within the model viewer also apply to the CAD program.
- CAD rotation → Ensures that the display in CAD has the same orientation as that appearing in the model viewer.
- Show CAD → Allows the selected, active layers from the current CAD illustration to be displayed in the model viewer, superimposed on the images.
- Refresh CAD → Refreshes the model viewer display, reloading the layers to be shown.

In order to select illustration layers, click on ***Layers…*** in the CAD control window (Figure 28)

Illustration functions: allows the model viewer to strip to “Blocked mode”. The left and right mouse buttons allow you to control the illustration on starting up any of these functions, along with the keys assigned during program customization.

- Draw Points: Move the mouse and the scroll wheel in order to situate the cursor in the position where you wish to place the point. Left clicking confirms the designation of the point. You may designate as many points as you wish. Left click to finish the operation.

- Plotting 2D contours: On starting up this operation from the CAD toolbar on the model viewer, the 2D curve parameter window will appear. This window allows you to set parameters which define operation performance in terms of two aspects:

  1 - Registry: Establishes how many points are to be eliminated on each sweep (using the configured delete key) and the registry distance, the distance from the last point of the cursor position, automatically added as a new point.
  2 - Elevation variation: Allows you to draw a 2D curve and, when finished, the model viewer to situate the display at the start point, although with the elevation difference due to the “Elevation variation” value in the indicated direction.

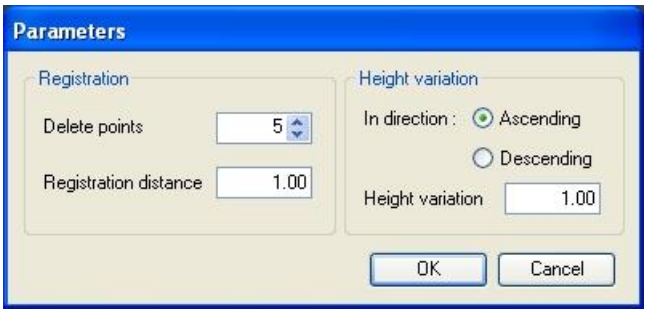


Figure 35 – 2D curve function parameters.

Once the parameters have been set, you may move the mouse and the scroll wheel in order to situate the cursor in the position where you wish the curve to start. Bear in mind that once started, the elevation cannot be changed (the scroll wheel and keys assigned to change the elevation will have no effect).
In this case, left clicking will start, detain and continue the plotting of the curve. If the illustration is active, on moving the cursor points will be added. If the plotting of the illustration has been detained and you continue it, points will be inserted from the last plotted point to the current cursor position, based on the distance from the current registry.

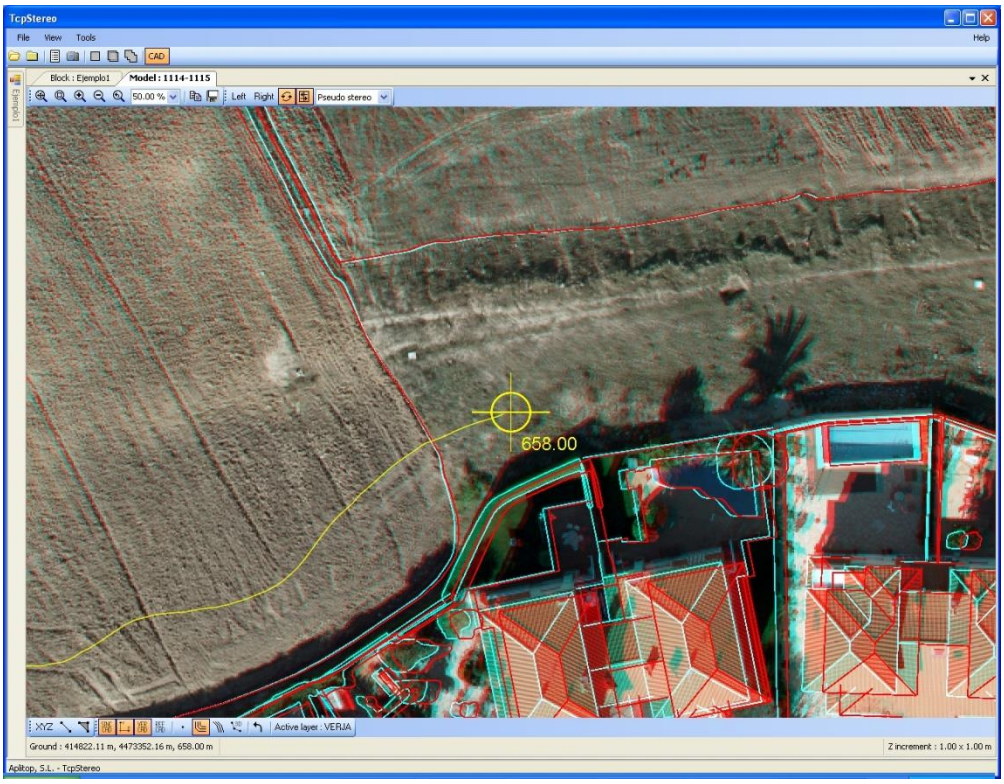


Figure 36 – Plotting 2D contours.

If you right click, regardless of whether the illustration is active or not, points will be inserted from the last plotted point to the current cursor position, finishing the curve, but maintaining the command, meaning that a new curve can be initiated at the same elevation. If you right click again, the 2D curve plotting command is closed and the viewer returned to its initial plotting position, with the elevation resulting from the application of the “Elevation variation” parameters.

Note: *When the viewer is not in Blocked Mode, right clicking will repeat the final plotting operation (point, 2D curve, incline or 3D polyline) undertaken, without the need to establish parameters, should they be required.*

2D contours are perfect for plotting contours, and are also suitable for representing the edges of flat surfaces.

- Plotting slanted lines: On starting up this operation from the CAD toolbar on the model viewer, the incline parameter window will appear. This is done in a similar way to the plotting of 2D contours, although only registry parameters can be set, given that in this case, the elevation can be modified, meaning that automatic control of the position based on the elevation is not necessary.

Figure 37 – Incline function parameters.

In order to plot slanted lines, the functions of the two mouse buttons varies slightly, as follows:

- The left button is used to start or continue the plotting of the incline. If it is already plotted, left clicking registers the current elevation for subsequent interpolation.
- Right clicking detains plotting, if this is in progress. If the plotting has already been detained, it finalizes the operation.

The incline plotting tool features two types of interpolation:

- An interpolation in XY, based on registry distance, in exactly the same way as when plotting 2D contours.
- Another interpolation in Z (elevation), where at each intermediate point between marked points (designation of the current elevation) an elevation value is assigned between the height of the first and second registered points, based on its position within the polyline defined by the registry points.

- Plotting a 3D polyline: This plotting function also allows a 3D polyline to be created, with the left mouse button used to designate the vertices of the polyline. Right clicking finishes the polyline.

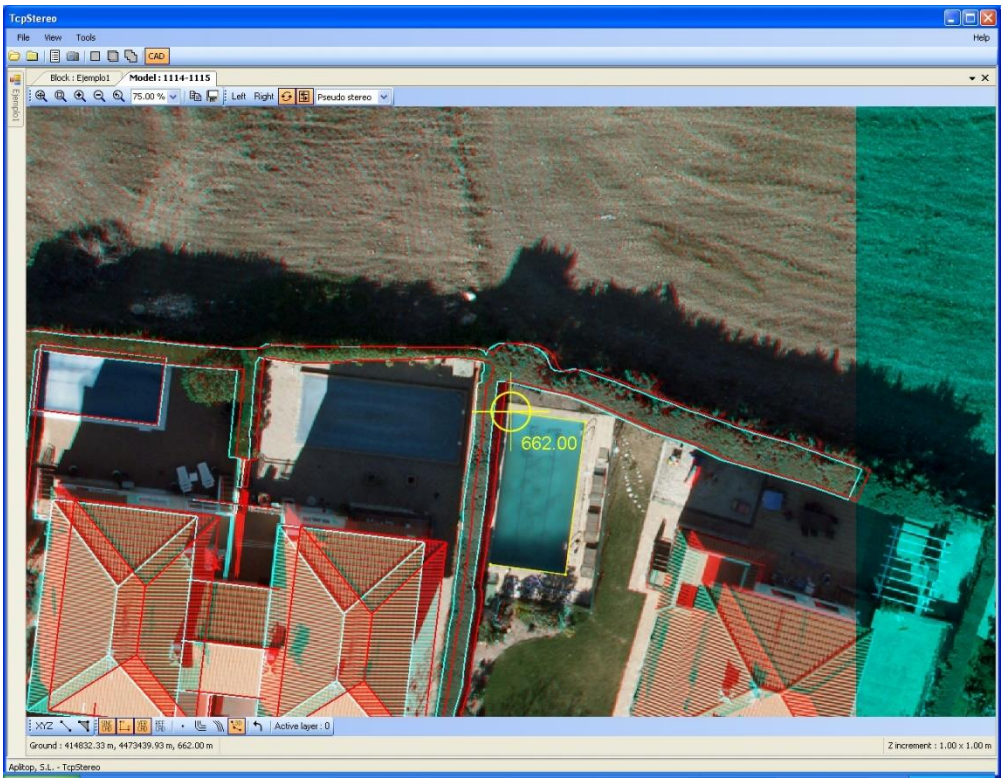


Figure 38 – Plotting 3D lines.

Very important – Specific keys

In the ***Customization*** section, there is a paragraph which refers to specific model viewer keys. A specific set of keys designated for stereo plotting. Ensure you have set up and remember these designations, as they allow greater control over plotting, with the following options:

1) “Finish plot” key: Immediately finishes the current plot.
2) “Close plot” key: Closes the current plot.
3) "Delete points” key: Deletes one or more points from the plot.
4) "See last point” key: Positions the viewer from the last plotted point.
5) “Next point” key: Situates the cursor on the vertex coordinates closest to the present plot on the active layer, excluding the current plot, and designates a new vertex to these coordinates.

Additional functions:

- Undo: Once a plot has been finished, this tab allows a number of vertices to be deleted from this polyline.
- Active layer: This is not really a function, instead it shows the name of the layer of the plot in the CAD application that is currently used as the active layer.

Very important – Layer selection

The active layer will be set on the CAD application.

The visible layers will be those which are designated in layer selection dialog box which appears when you click on ***Layers…*** in the CAD control window (Figure 28).

Figure 39 – Layer selection dialog box.

This is a very intuitive dialog, where on the left-hand side the available layers appear in the CAD illustration, whilst on the right side the layers are shown on the stereo in the model viewer. You can move layers from left to right using the tabs that separate both lists.

Note: *On connecting TcpStereo to the CAD program, and setting up a model viewer to display CAD layers, the layer selection dialog will automatically appear. If it is not visible the TcpStereo window might be hiding it. Click on the CAD program, making it the active application, to make the layer selection dialog come to the forefront.*

3.2.4. MULTIPLE VIEWERS MANAGEMENT

When you have a number of viewers open at the same time, these are organized into tabs, meaning that each is accessible by clicking on the title.

As has been mentioned earlier, the strip and model control windows (Figure 24) are initially automatically hidden, and can be set and anchored to the edges of the main window. It can also be left as a floating window, allowing you to move and resize it as you wish.

Something similar can be done with the viewers, with it possible to view various at one time, in differing formats and sizes.

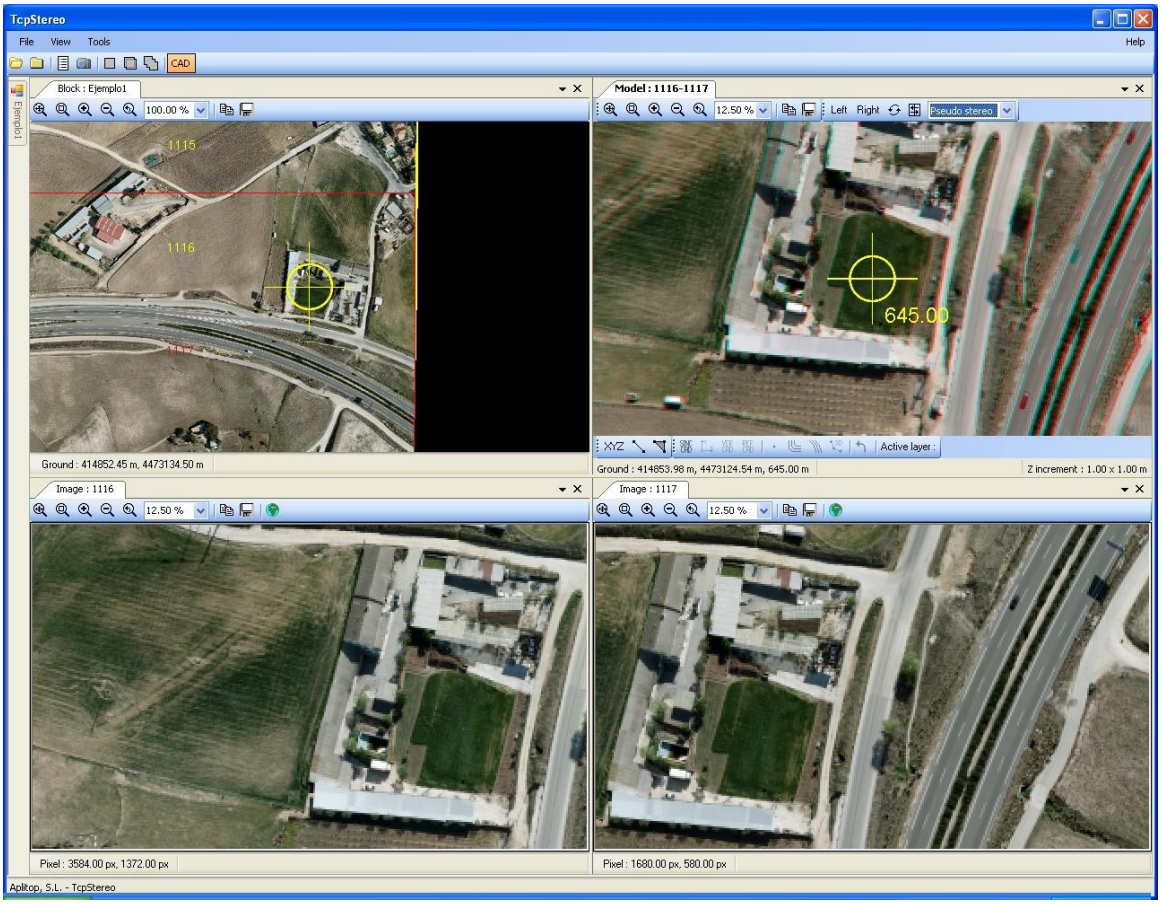


Figure 40 – Multiple views with different viewers.

In order to achieve this, double click on any anchored viewer or drag it (left click and move the mouse), making it a floating window. If you double click on the title bar of the floating window, it will return to its fixed position, or you can drag it and set it in a new position. You can also anchor floating windows within other fixed or floating windows.

If the ***Automatic model change*** option is activated during set-up, it is recommendable to have a single model viewer open, as when moving within a model you might find yourself with the same model open in two viewers.

3.3. TOOLS

This sub-menu within the main menu gives you access to TcpStereo's customization options and the creation of complete pyramid images (maximum resolution).

3.3.1. SET UP

See the ***Customization*** section.

3.3.2. GENERATION OF PYRAMID IMAGES

As mentioned during digital flight project import, it is possible to carry out a reduced import which allows you to complete the import in less time, resulting in images with a lower resolution than the originals. The creation of pyramid images allows you to generate images which are visible in full mode. To do so you will need to have the original images. In order to start the pyramid image generation process, via the main menu run the sequence ***Tools > Create pyramids***. A dialog box will appear enabling the generation of complete pyramid images, described below:

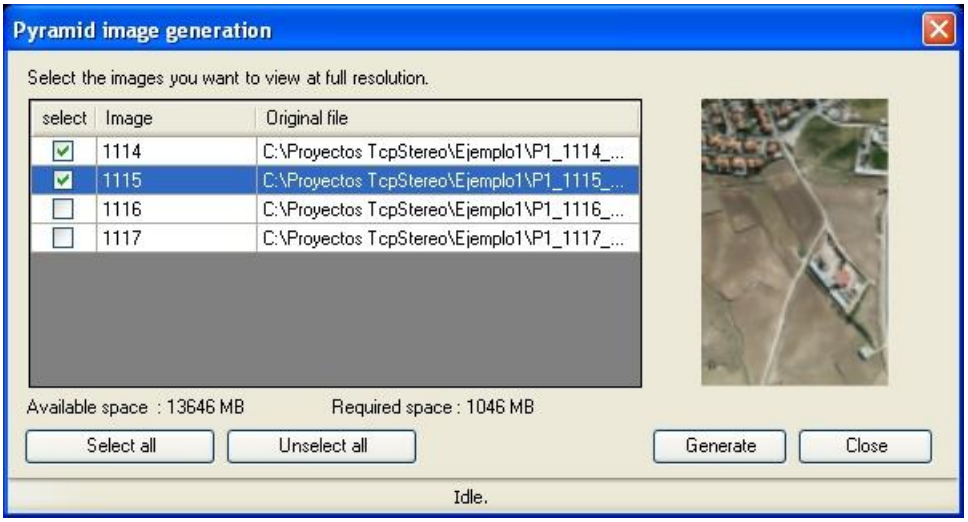


Figure 41 – Pyramid image generation dialog box.

In the table a list will appear with the images that make up the project. You can select the images to be converted by checking/unchecking the boxes on the left and using the buttons ***Select all*** and ***Deselect all***. On the right you will see a preview of the image corresponding to the selected line. The lower part shows information concerning available disc space required by the generation of pyramids. If the line corresponding to an image has a grey background, it means that the image in question has been converted into a pyramid image, thus blocking it from being generated again.

At the bottom of the dialog box a progress bar will appear with text giving information as to the current situation or the result of the conversion operation.

Once a set of images has been selected, clicking on ***Generate*** will launch a process that will create a pyramid image from each selected image. This process can be cancelled, although you should allow the current image conversion to finish.

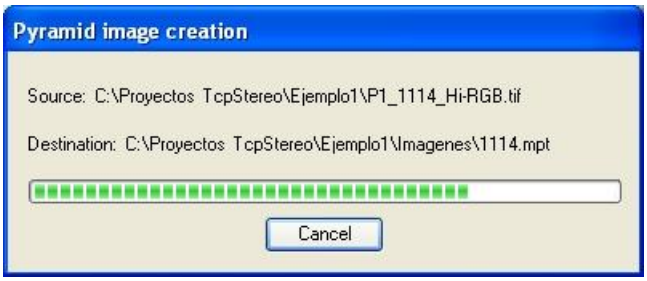


Figure 42 – Generating a pyramidal image.

Once the process has finished, the table is updated to reflect the new status. The pyramid image generation dialog box can now be closed or else you can continue to select and create pyramid images.

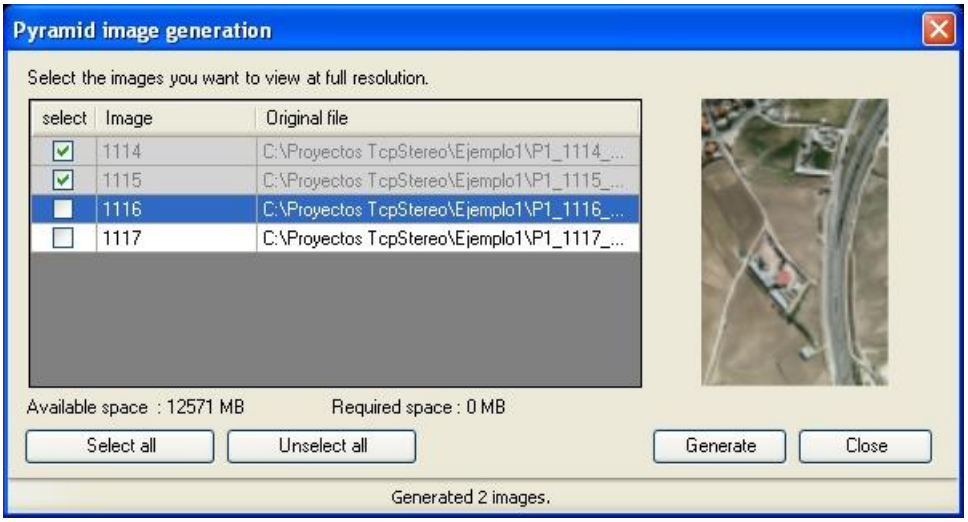


Figure 43 – Result of the pyramid image generation.

Note: *If no pyramid image is generated from a project imported in reduced mode, when striping to full mode, it is normal and logical that no element appears in the image and model control window.*

3.4. HELP

Through this option from the main menu you can access reference manual, as well as the program information dialog box.

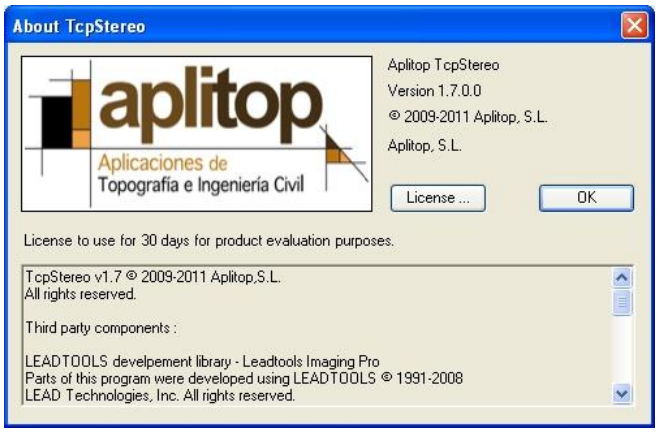


Figure 44 – The "About TcpStereo" dialog box

4. CUSTOMIZATION

A number of program aspects can be customized, and certain function parameters can be established. In order to do so, go to ***Tools > Set up***. A window will appear showing a series of tabs, the content and meaning of which is explained in the following sub-sections.

4.1. GENERAL

In the "***General*** tab three groups appear. The first of these ***Language*** allows you to select the language you wish the function to appear in. The languages currently available are Spanish and English. If you decide to change language, the application will restart in the selected language.

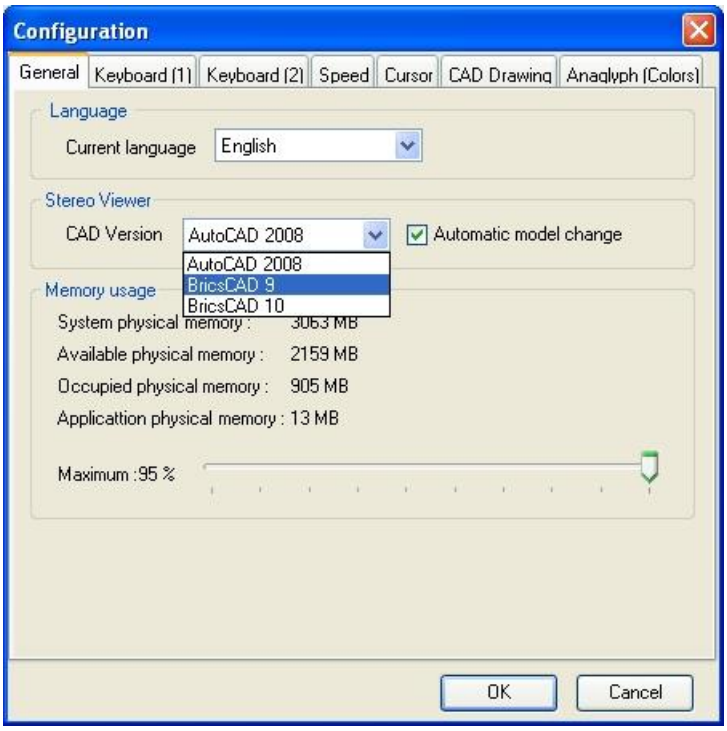


Figure 45 – General set up.

In the second group - ***Stereo viewer*** there is a drop down control menu showing the different CAD versions which are compatible with TcpStereo installed on the computer. The selected version is the one that TcpStereo will connect to. There is also a checkable box that allows you to indicate if the model will change automatically as the user moves over them or if the model change has to be made manually.

Finally, the group ***Use of memory*** shows information as to the current state of the physical memory installed on the system. The slider control establishes a maximum value for occupied memory, from which point the program will not allow more image or model viewers to be opened. It is recommended that this limit be set as high as possible in order to prevent the blocking of new viewers.

4.2. KEYBOARD

There are two tabs ***Keyboard (1)*** and ***Keyboard (2)*** which facilitate the set up of the keypad for interaction with the various viewers. In order to assign a key to a function, use the mouse to select box associated to the function, then click the key you wish to assign to the function in question. Bear in mind that certain “special keys” cannot have a function assigned to them (Escape, Intro, etc.) whilst assigning keys already used to a new function will mean that that function has no assigned key.

The tab ***Keyboard (1)*** features a group ***Movement and Scale***, which covers the keys used to move on the X and Y axes, and to control the various zoom functions on the toolbars (common to all) for all viewers via the keypad.

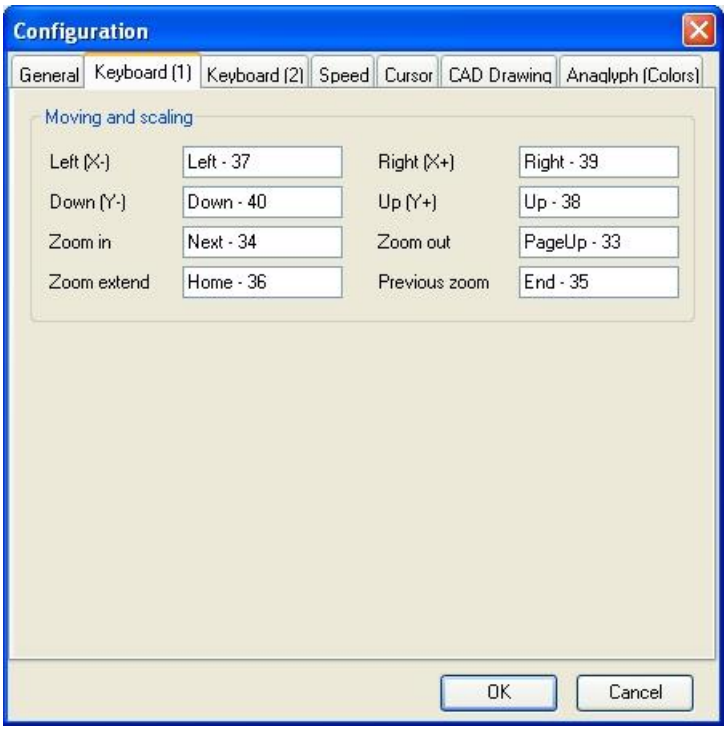


Figure 46 – Keypad (1) set up.

The tab ***Keyboard (2)*** is specific to the model viewers and is structured into three groups:

- The ***Height variation*** group
  This establishes which keys allow variations to be made to the elevation (Z) as well as speed and the variation factor.
- The ***Stereo vision*** group
  This is used to associate keys to various specific stereo viewer functions, which correspond to those on the stereo model viewer toolbar.
- The ***Stereo drawing*** group
  This final group assigns keys to special function that can be carried out whilst plotting a CAD drawing from a model viewer.

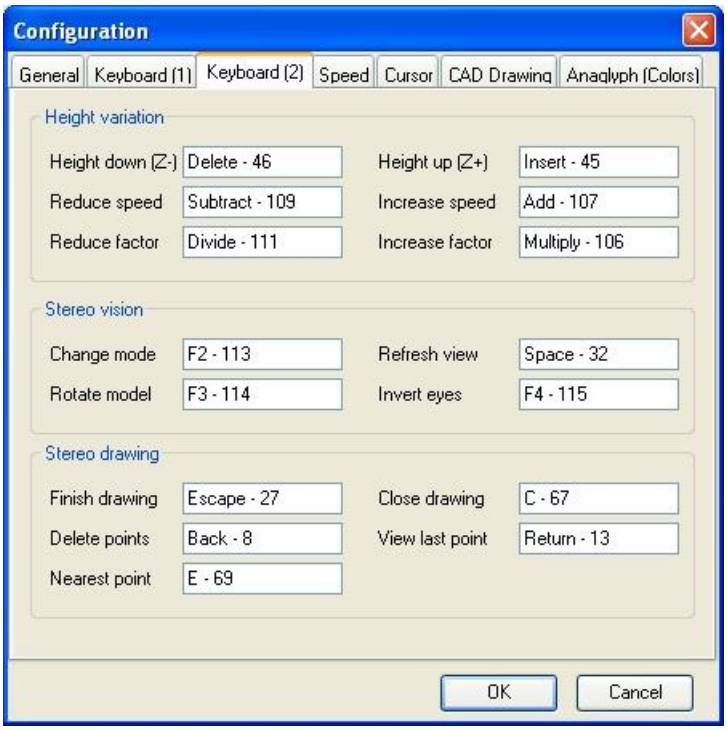


Figure 47 – Keypad (2) set up.

The meaning of the various keypad functions is explained in the ***Viewers*** section, with each detailed in the applicable section.

We recommend that the user assigns keys in an easy to remember form and that their distribution is comfortable to use, bearing in mind you will be keying them frequently.

4.3. SPEED

This tab determines the speed that the display moves on the X and Y axes when using the different viewers. It also specifies the speed at which the elevation (Z axis) can vary in stereo viewers, and the manner in which it does so. Finally, the speed at which the zoom varies is indicated, in a similar way to the speed in which the elevation can alter. Adjust all these values in such a way that movement and scale is most comfortable for you.

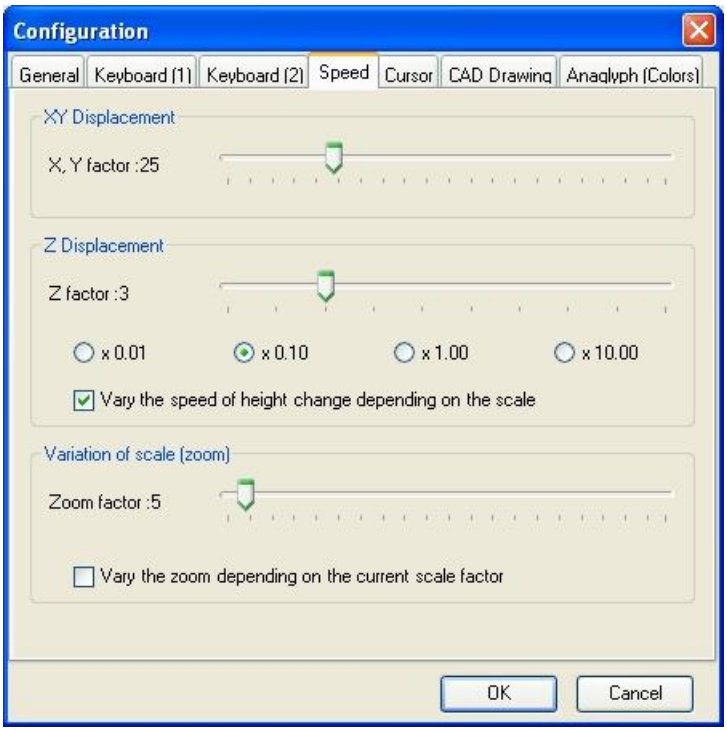


Figure 48 – Speed set up.

Displacement in X and Y is done on an image pixel level, whilst displacement in Z is done using terrain coordinates (meters).

In the case of Z displacement, you can set both the amount of variation and the units by which it varies, from a centimeter to ten meters.

The checked boxes can be linked to Z displacements and the variation in scale to the scale currently present in the viewer, ensuring that the variations of these values are proportional.

4.4. CURSOR

The cursor is visible both in the block and the model viewer. The second may feature a text which shows the current elevation. It appears in the frame with a dark grey background.

In order to personalize the cursor in both viewers, use this set up tab. Via the ***Cursor shape*** drop down menu you can change its appearance, selecting from *Crosshairs*, *Cross* and *Point*. You can also add a circumference to the cursor. In the lower part there is a control feature which changes the size of cursor, as well as a tab to set its color.

In the case of model viewers, you can choose whether or not the elevation appears alongside the cursor, and if so, the font style, size and color, as well as the position of the text with respect to the cursor. Use the arrowed tabs to move the text, and the central tab to return to the initial position.

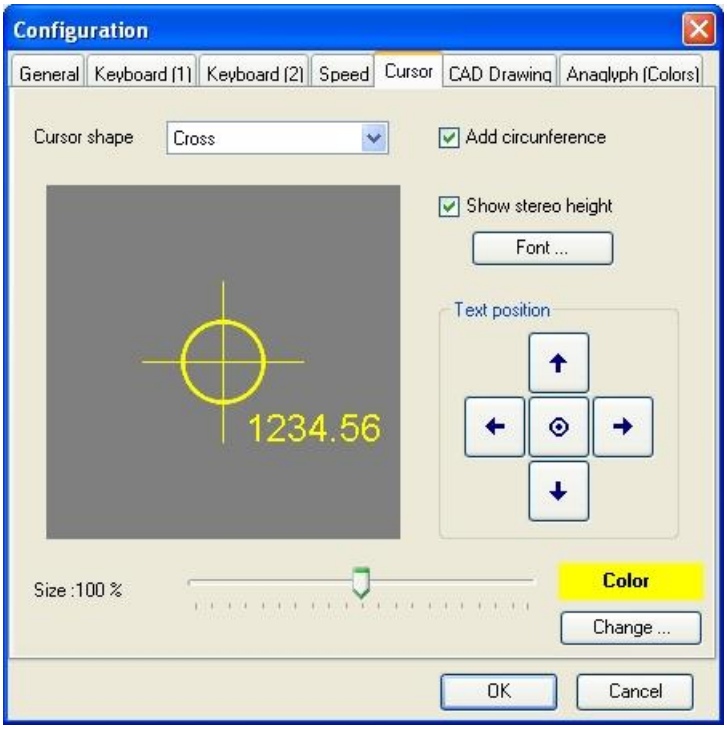


Figure 49 – Cursor set up.

Note: In order to move the text more quickly, click on the arrow that corresponds to the direction you wish, and set it by clicking on Intro. The text will continuously move in this direction until you release the key.

4.5. CAD DRAWING

The ***CAD Drawing*** tab allows the user to set the way in which plot drawings are shown in the stereo viewer, when this is connected to a CAD application. Specifically, you can set:

- The color and thickness of the plot in the stereo viewer.
- The color and thickness of the plot in the active layer.
- The color and thickness of the plot in the visible layers, designated in the layer selection dialog box (Figure 39)

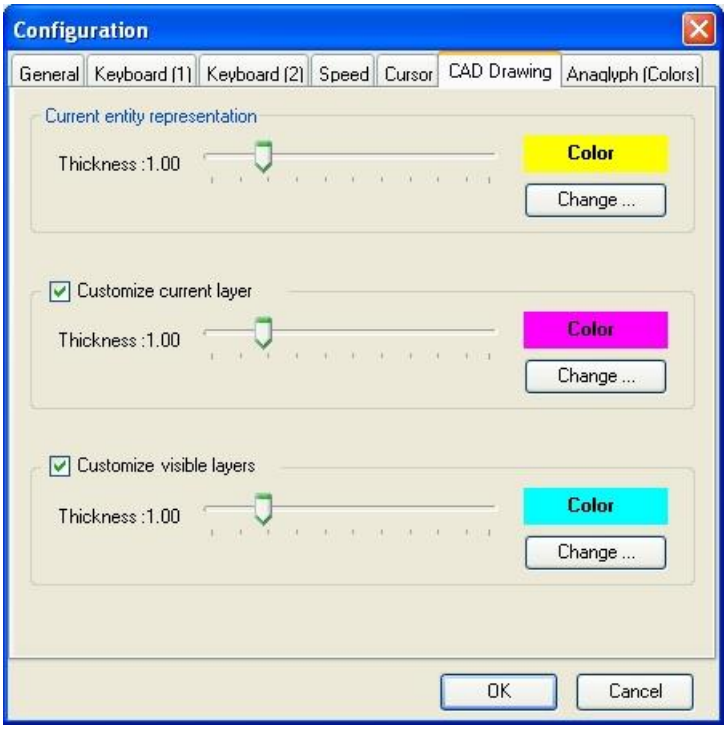


Figure 50 – CAD edition set up.

If the boxes in the ***Customize the current layer*** and ***Customize visible layers*** groups are checked, the color and thickness established for each tab. If not, the color and thickness will be those used in the loaded CAD plot for each layer.

4.6. COLOR (PSEUDO-STEREO)

The ***Color*** tab allows the user to set the color filter for the left and right images for each model, which will be applied when setting the model viewer to ***Pseudo stereo*** mode. To this end, two sets of slider bars are displayed, showing red, green and blue, associated to the images of a given pair. Additionally a series of buttons are available which allow you to establish a color set up for each image in a pair, meaning that the image can be anaglyphically viewed in stereo. The last tab in this series establishes a color balanced set up (non-stereo) which allows both images to be viewed in color.

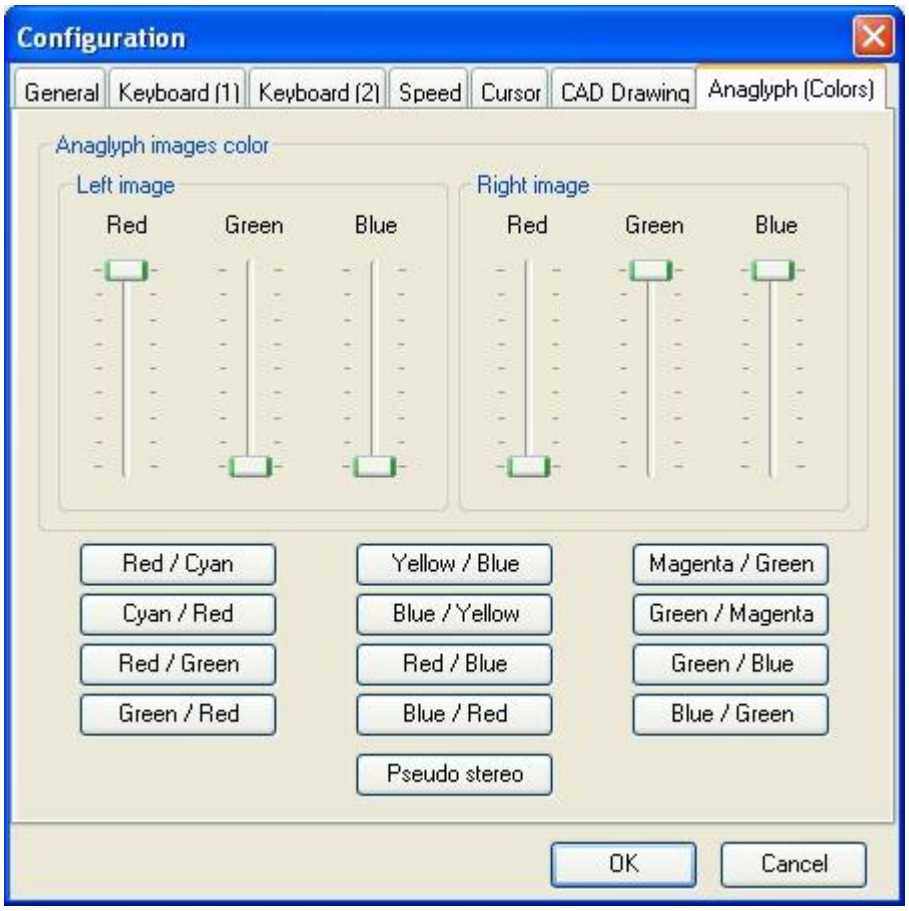


Figure 51 – Color component set up.

5. ACKNOWLEDGEMENTS

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- TDT_SL Patrimonio Histórico, Técnicas Documentales Terrestres owner of the images from Chanza, Huelva.